NC STATE UNIVERSITY

scope

SPRING/SUMMER 2007 A LOOK INSIDE THE COLLEGE OF PHYSICAL AND MATHEMATICAL SCIENCES

A global view on climate change:

NC State faculty and students travel the world in their quest to better understand global warming.

scope

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Dean
Daniel Solomon

Editor
Anita Stallings

Writer
Sally Ramey

Contributing Writers
Tracey Peake
Ryan Boyles
Matt Burns

Design
Zubigraphics

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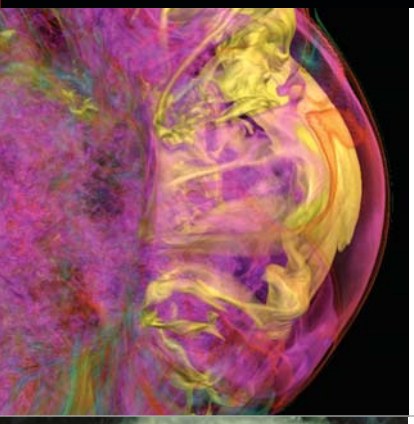
On the cover:
Professor Dave DeMaster of the Department of Marine, Earth and Atmospheric Sciences sits near a large group of Adelie Penguins on Torgeson Island, which is located near the U.S. Palmer Research Station on the Antarctic Peninsula. Photo courtesy of Dave DeMaster.

in this issue...

SPRING/SUMMER 2007



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Humanity's greatest challenge?

PHOTO BY ROGER WINSTEAD

Dean Daniel L. Solomon

When we think about society's greatest challenges, there are several notable contenders: disease, world hunger and war, to name a few. But in recent months, the vast majority of scientists worldwide have agreed that global warming is real, it's serious, and there is overwhelming evidence that humanity has caused it.

The Intergovernmental Panel on Climate Change has outlined many expected outcomes of global warming. While the timeframe is debated, there is little argument that in the not-so-distant future, coastal cities will be flooded by rising seas, forcing the relocation of much of the world's population, which is largely congregated in coastal communities.

And there are other projected effects – agricultural productivity will eventually suffer, severe weather events will become more frequent, and there will be extinctions of plants and animals as habitats change. Many parts of the world are already seeing this occur. For example, the polar bear is threatened by its quickly changing habitat, and several tropical frog species have disappeared.

Imagine what this means for our grandchildren, who must live in this new, warmer world. And we can't stop it – research indicates that even if we were to stop all production of greenhouse gases today, we have already set in motion enough change that climate will take 400,000 years to return to what we think of as normal.

In a very short time, we have released into our atmosphere immense amounts of carbon dioxide that had been stored away in other forms for millions of years.

The world's climate has changed many times due to natural processes. We can examine geological evidence for very good information about what to expect from a warmer planet. We also can generate computer models that can forecast the effects. But we need to do more research. As quickly as we think we know what's happening, nature surprises us. Just recently, scientists announced that glaciers and ice packs were melting at a rate five times faster than previously predicted.

We must also bring a local perspective to the issue. Most research and computer modeling have been done on a global level, but the effects will be felt on a more local level, and will vary significantly from place to place. We need more research to better understand what these localized effects of warming may be.

Closely related to climate change is the world's growing appetite for energy. This is what got us into this predicament in the first place. In a very short time, we have released into our atmosphere immense amounts of carbon dioxide that had been stored away in other forms for millions of years.

What will we do about our energy needs? What new, cleaner technologies must be developed before we, and emerging economies, build more fossil fuel-burning plants? We'll explore the energy issue in greater depth in a future issue of *Scope*, and our guest speaker at the 2007 PAMS Alumni & Friends Weekend will speak on this topic (see back cover). This issue of *Scope* contains a focus on global warming itself – perhaps our greatest challenge as a species, and as scientists. It is up to scientists to understand these changes, which is the first step in figuring out how to cope with them.

Recently, NC State has had several high-profile lectures and seminars featuring leading figures in the global warming arena. While the news has been sobering, particularly regarding political reluctance to change public policy, there are many reasons to feel optimistic about our ability to adapt.

At NC State, we have many faculty who are working to increase our knowledge about climate change and its effects. I hope this information will help you gain new insights into this far-reaching issue.

Daniel L. Solomon

Daniel L. Solomon, *Dean*

PHOTO BY ROGER WINSTEAD

Alex Deiters

Notables

Robert Beichner (Physics faculty)—2007 Distinguished Service Citation, American Association of Physics Teachers

Robert Bryant (PhD '74 Mathematics)—Member, National Academy of Sciences and Director, Mathematical Sciences Research Institute

Daniel Comins (Chemistry faculty)—NC State Distinguished Service Award

Alexander Deiters (Chemistry faculty)—2007 Beckman Young Investigator Award

Rebecca Doerge (PhD '93 Statistics) – Fellow, American Statistical Association

Brent Gunnoe (Chemistry faculty)—LeRoy and Elva Martin Award for Teaching Excellence

Jacqueline Hughes-Oliver (Statistics faculty)—Fellow, American Statistical Association

William Hunt, Jr. (Statistics faculty)—Outstanding Extension Service Award

Min Jeong Kang (Mathematics faculty)—Outstanding Teacher Award and NC State Academy of Outstanding Teachers

Dean Lee (Physics faculty)—Outstanding Teacher Award and NC State Academy of Outstanding Teachers

Kay Sandberg (Chemistry faculty)—Alumni Distinguished Undergraduate Professor

John Seely (BS '68 Physics)— Fellow, American Physical Society

Phil Summa (MS '75 Chemistry)—North Carolina's Legal Elite—patent law, *Business North Carolina* magazine

Russell Wolfinger (PhD '89 Statistics)—Fellow, American Statistical Association □

Swallow receives UNC System teaching award

William Swallow, professor of statistics, recently received the University of North Carolina (UNC) Board of Governors' most prestigious award for teaching.

Swallow is one of 16 educators – one from each UNC System campus – who was presented the Award for Excellence in Teaching by UNC System President Erskine Bowles and Board of Governors Chairman Jim Phillips, Jr. during a special awards luncheon. Winners received a prize of $7,500 and a bronze medallion.

These awards were created in 1994 to underscore the importance of teaching and to encourage, recognize, and reward outstanding teaching.

"It is a great honor, privilege and responsibility to be a teacher. We routinely have the opportunity to show the beauty, importance and excitement of our subject – or to snuff out any spark of interest," Swallow said of teaching.

His teaching methodology is centered on the belief that using multiple teaching styles and empowering students is critical.

Jimmy Doi (MS '98, PhD '03 Statistics), now a professor of statistics at California Polytechnical, said in Swallow's nomination, "Although he has a definite start and finish in mind for his presentations, he actively involves the class members in much of the lectures, giving the impression that the *students* are the driving force in navigating the class discussions."

Even when he was a doctoral student at Cornell, his teaching prowess was recognized, and he was tapped to teach his department's large premier statistics service course for graduate students from across the university, said PAMS Dean Daniel L. Solomon, who was a young assistant professor at Cornell at the time.

"Many of the techniques that I used for teaching throughout my career – I learned from Bill Swallow," said Solomon. "Fortunately, I watched him closely, for eventually he would graduate – and eventually, I would be entrusted with 'Bill's course.'"

"He encourages a healthy discussion of ideas in his classes and allows the students to critically think and become problem solvers," said Sastry Pantula, head of the Statistics Department. "He not only has high expectations for his students, but also has infinite energy to work with them to reach their full potential."

Swallow's research interests include experimental design and group testing. His work has special significance in public health research to determine frequencies of HIV seropositivity in various populations. He has directed the undergraduate and graduate programs in statistics, and advised more than 230 undergraduates, 40 master's and 13 PhD candidates, as well as mentored five Park Scholars.

Before coming to NC State in 1980, Swallow was professor of statistics at Rutgers University, where he was named 1974 Cook College Professor of the Year. He received the Outstanding Teacher Award at NC State in 1988, and was named Alumni Distinguished Undergraduate Professor in 1999. He served on the planning/organizing committee and the founding editorial board for *The Journal of Statistics Education*.

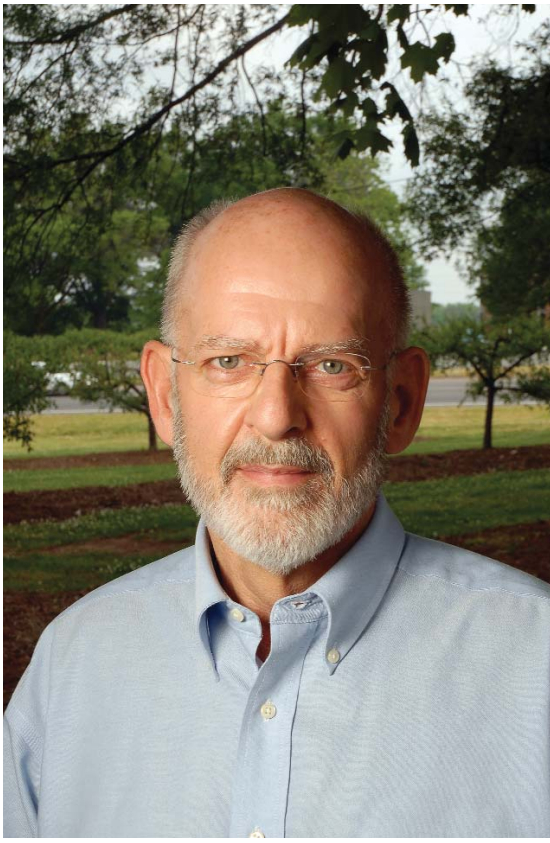


PHOTO BY ROGER WINSTEAD

Bill Swallow

Swallow received his bachelor's degree in social relations from Harvard University, and his PhD in biological statistics from Cornell University.

He is retiring after 27 years at NC State. □

Realizing Possibilities Dinner honors donors, teachers

Since 1999, the College has presented a special dinner to celebrate two groups of people who have helped its students and faculty achieve their dreams: the K-12 teachers who inspired its students, and the donors who support the endowments that in turn support its students, faculty and programs.

"Saying 'thank you' is just not enough," said Anita Stallings, executive director of Development and College Relations. "We started the Realizing Possibilities (RP) Dinner as a way to recognize these individuals and to show them that their efforts and support do produce concrete results, and are truly appreciated."

Many times, donors contribute to various causes, and never hear whether or not their investment accomplished anything. Likewise, K-12 teachers watch their students graduate, and may never know what happens to them later. RP offers both groups a chance to see the results for themselves.

Almost 200 people attended the 2007 RP Dinner, which was held at Prestonwood Country Club in Cary. About half of the attendees are endowment donors, and the other half includes students and faculty. Donors are seated with the students or faculty who benefit from the endowments they support.

"This allows the donors an opportunity to meet and visit with their award recipients," said Stallings. "It also allows the students and faculty a chance to personally express their gratitude for the endowment support."

Some donors develop relationships with students that extend beyond the dinner.

"Our endowments support a variety of needs, which include scholarships, fellowships, faculty support and The Science House," said Stallings. "Through RP, our donors can maintain their connection to the College, and the individuals or programs their funds support."

Each year, about a half-dozen students have the challenge of expressing gratitude that represents all of the endowment beneficiaries within the College, and all of the students who have been inspired by special teachers. Their stories can be profound and touching, or humorous and lighthearted.

Turhan Carroll explained to the crowd at the 2006 RP Dinner that his father had died when he was young, and his mother became disabled. He and his brother worked to support their family while in high school, with hopes to send Carroll to college … somehow.

Scholarships made it possible for Carroll to attend NC State, where he double-majors in mathematics and physics. Instead of working long hours to get by while in school, Carroll has taken advantage of several outstanding research opportunities.

"Because of these funds, I have been able to work less, and focus more on my studies," he said. "I count it a blessing just to be able to attend college, because it is very easy for someone in my situation to become a statistic. So thank you for this opportunity, and thank you for believing in me."

Lara Pagano, a senior in meteorology, paid tribute to her high school English teacher, Ann Ennis of Mt. Airy, NC, at the 2007 dinner. Severe vision problems that went undiagnosed for several years left Pagano far behind on her

PHOTO BY BECKY KIRKLAND

The Realizing Possibilities Dinner allows students and donors to get to know each other. Shown here are Jessica Langford, Bill (BS '72 Mathematics) and Susan White and William Myers.

"I learned that there are very generous people in this world, who recognize that some of us need a little help starting out. By establishing or supporting scholarships, you make it possible for students to pursue their dreams. Many of us wouldn't be here if it weren't for you. I know I probably wouldn't be."

Al Hopping, Physics

"If future generations are going to realize their possibilities, schools must have teachers like Nancy Hetrick to provide students with the potential to grow, the passion to lead, and the power to make our world better. To Ms. Hetrick and to all those here tonight, thank you for helping us realize our possibilities."

Albert Blackmon, Mathematics

"I would really like to thank the Mary Alice and Hubert Park family, personally for giving me a sense of freedom, achievement and encouragement, but more importantly, affording me the opportunity to go for my goals and live out my dreams."

Eliza Britt, Mathematics

English skills. Ennis used innovative, personal instruction strategies to help Pagano catch up.

"Ms. Ennis taught me about patience and believing in oneself. I never lacked motivation–I lacked confidence. She did not give up on me and would not let me give up on myself," she said. "In fact, because of her, I became an even better student at math and science, and it is because of her that my dream of becoming a meteorologist will come true."

Statistics major Jera Mendenhall was the recipient of a SAS Scholarship, which also provides the opportunity to gain work experience at the company. Her family also had financial challenges, she told the 2005 dinner audience.

"I started my time at NC State struggling to collect enough financial support to make it. And because of the generosity of one of my College's partner corporations, not only am I making it, but I am living a dream I will remember the rest of my life," she said.

Some students explain that their scholarships were the key reason they chose to attend NC State.

"This is an important point because our students are frequently offered large scholarships by other universities," Stallings said.

Sarah Reising, a physics major, was one of those students. She received the Thomas A. Hill Scholarship and Nancy Chung Physics Scholarship.

"I was certainly interested in attending NC State, but receiving these scholarships made me feel appreciated as a student, and recognized for all of my hard work during high school." Reising said in 2003. "I can say that receiving this support definitely helped me decide to choose NC State."

The students describe how they've spent their time at NC State. Many use research opportunities to gain experience working in laboratories either on or off campus. Some do field research in Iceland or other far-away places. And still others take on leadership roles of student organizations within PAMS or elsewhere in the university.

"I think it makes donors feel confident that our students are learning to be well-rounded participants in society," Stallings said. "And that they're taking advantage of all of the opportunities afforded them within the university environment."

It's not unusual to see a few tears at the RP dinner, and hugs between donors, students and faculty afterward.

"Wherever their paths take them, our students' ability to be successful will be directly influenced by our donors' support of the College," said Dan Solomon, dean. "Someday, they may make discoveries that change the world, or save lives, or expand the frontiers of science, or inspire the imaginations of tomorrow's children. We look forward to, and celebrate, all of those possibilities." □

PHOTO BY BECKY KIRKLAND

Frank Smith (BS '63 Applied Mathematics), center, visits with other guests at the pre-event social.

"The Joyce Hall Aspnes Scholarship has allowed me to go to school without having to work during the school year. This enables me to concentrate on schoolwork more, without the worry of making money to help pay for college. I will be able to graduate debtless, and that is a big plus for people starting out on their own, especially in today's economy. I have many classmates who are not as fortunate as I am. "

Mary Snipes, Chemistry

"I gained a great understanding for the subject of calculus that left me more than prepared to enter college. But I learned a lot more than calculus from Mrs. Norma Hill. She taught us to struggle and work hard. Nothing was spoon-fed. She taught the facts, but more importantly – she taught me to think."

Karen Donaghy, Statistics

Big booms in astrophysics

Two recent discoveries by NC State astrophysicists have expanded our understanding of supernova explosions. In fact, their discoveries changed long-held beliefs about these massive explosions.

John Blondin, professor of physics, has developed a three-dimensional computer model that shows how pulsars obtain their spin, which could lead to a greater understanding of the processes that occur when stars die. The findings were published in the Jan. 4 edition of the journal *Nature*.

With colleague Anthony Mezzacappa at the Oak Ridge National Laboratory, Blondin used the CRAY X1E supercomputer to develop a three-dimensional model of a pulsar's creation, and in the process discovered that conventional wisdom concerning the formation of these celestial objects wasn't correct.

Pulsars are rapidly rotating neutron stars formed in supernova explosions, which occur when a massive star reaches the end of its life and explodes. The remaining matter is compressed into a dense, rapidly spinning mass – a neutron star, or pulsar – so called because scientists first discovered them due to their regularly timed radio emissions.

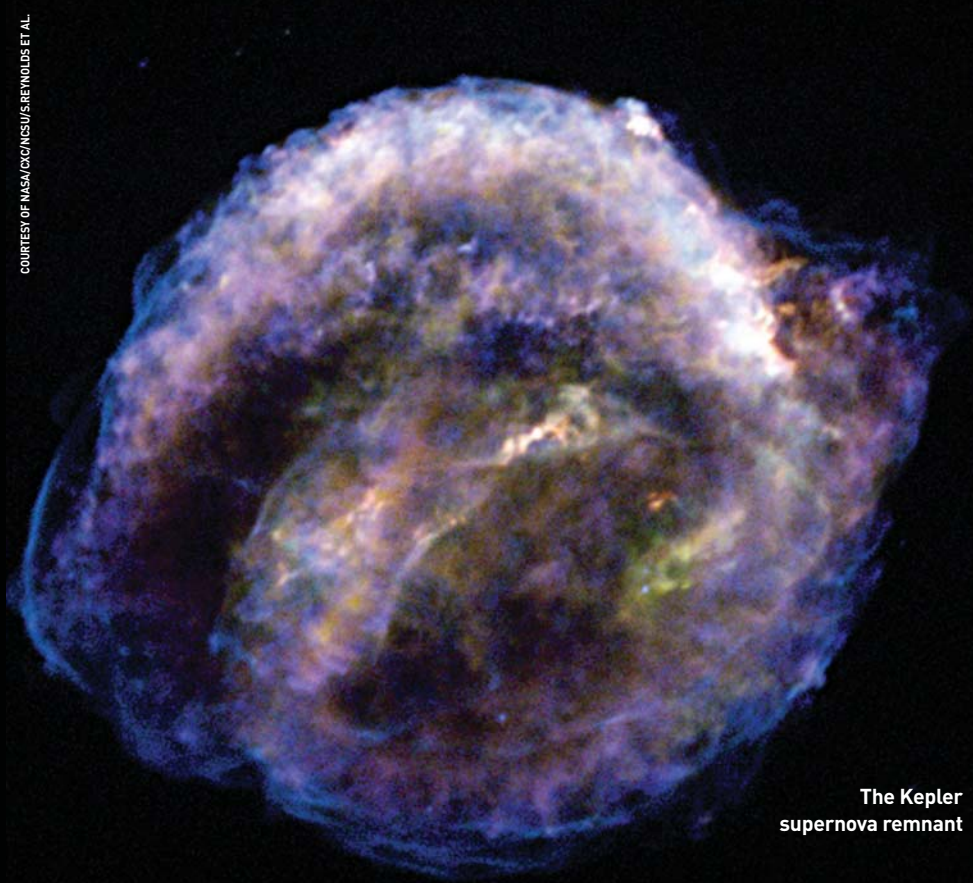
"Picture something about the mass of the sun being pushed down to the size of a small American city, like Raleigh," Blondin said. "That's what happens when a neutron star is formed." Pulsars were discovered in the 1960s.

"We can determine how fast they're spinning by how rapidly they pulse. It's like a searchlight on a lighthouse – as the pulsar spins, a beam of radio waves sweeps the earth, and we see a pulse. The period between the pulses tells us how fast it's spinning," he said.

Pulsars spin very rapidly – 20 or more times per second. Scientists assumed the spin was caused by the conservation of angular momentum from a star that was spinning before it exploded.

"Supernova explosions produce many of the heavy elements found on the periodic chart, like gold," he says. "Understanding these explosions can help us to better understand our own planet and solar system."

John Blondin



COURTESY OF NASA/CXC/NCSU/S.REYNOLDS ET AL.

The Kepler supernova remnant

"Think about how figure skaters start a spin with their arms and legs farther out from the body, and increase their rotation speed when they pull their limbs in more tightly," Blondin said. "That's the conservation of angular momentum – if you take a large object with a slight rotation and compress it down, the rotation speed will increase."

However, scientists had no idea if the stars that produced pulsars were even spinning to begin with. Blondin and his colleague decided to create a computer model of a supernova explosion using the new CRAY X1E supercomputer at the National Center for Computational Sciences, the only computer with enough processing power to accomplish the task.

The resulting model demonstrated that a pulsar's spin doesn't have anything to do with whether or not the star that created it was spinning; instead, the spin is created by the explosion itself.

"We modeled the shockwave, which starts deep inside the core of the star and then moves outward," Blondin said. "We discovered that as the shockwave gains both the momentum and the energy needed to blow outward and

create the explosion, it starts spiraling all on its own, which starts the neutron star at the center of the star spinning in the opposite direction. None of the previous two-dimensional modeling of supernova explosions had picked up on this."

Blondin hopes that this new information about the creation of pulsars will lead to a greater understanding of supernova explosions.

"Supernova explosions produce many of the heavy elements found on the periodic chart, like gold," he says. "Understanding these explosions can help us to better understand our own planet and solar system."

Two other members of the Physics Department faculty have shed even more light on supernovae.

Professor Stephen Reynolds, Research Associate Professor Kazimierz Borkowski and a team of scientists from NASA, Rutgers University and the Naval Research Laboratory, set out to determine whether the Kepler supernova, which occurred in 1604 A.D., was a core collapse supernova or a thermonuclear supernova.

They revealed their results in a press conference at the annual winter meeting of the American Astronomical Society in January.

A core collapse supernova is the type that leaves behind pulsars. It also tends to be surrounded by circumstellar medium – leftover material ejected earlier from the star that collapsed, as well as large amounts of oxygen and small amounts of iron. These supernovae are usually located near "star-forming" sites in the plane of a flattened galaxy like our Milky Way.

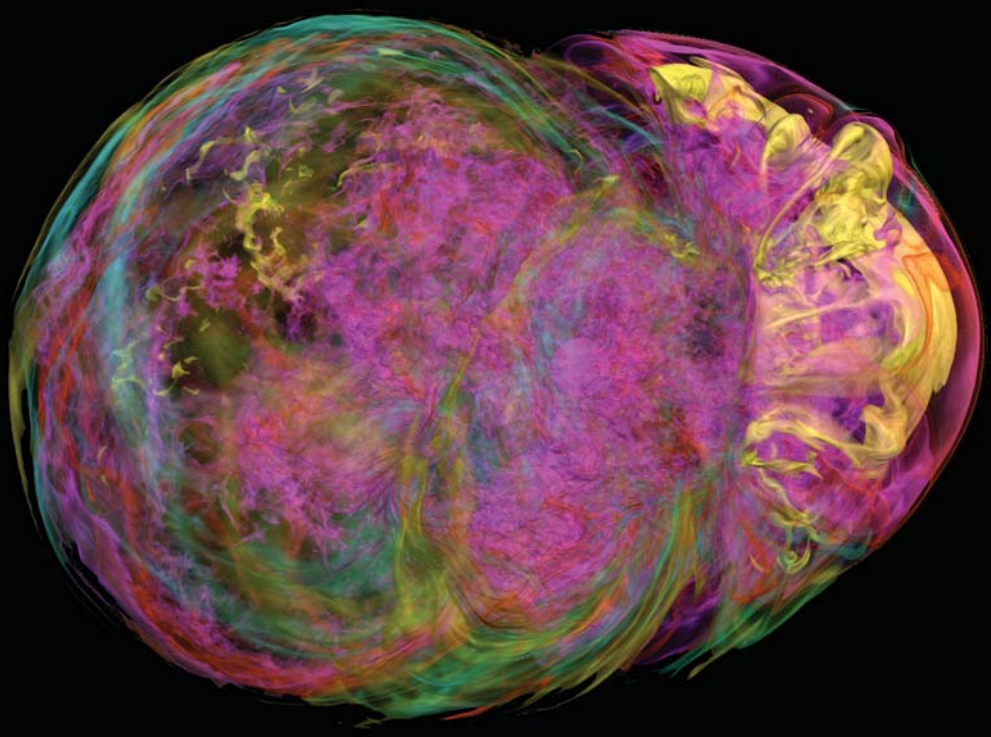
Thermonuclear, or Type Ia, supernovae occur when a white dwarf star, which typically travels through space with a companion star that eventually "leaks" its own mass onto the dwarf, reaches its mass limit and explodes. These supernovae can be found all over a galaxy, are typically not associated with any circumstellar medium, and produce large amounts of iron.

The Kepler supernova has long puzzled scientists because it has features that are common to both types of supernova: its location and the presence of a lot of iron are typical of a Type Ia supernova, but its dense surroundings and nitrogen-enriched circumstellar medium indicate a core collapse.

Using the powerful Chandra X-ray telescope to observe the Kepler supernova, the team discovered that Kepler is something entirely new: a Type Ia supernova in which the progenitor of the white dwarf star that created it had enough mass to create circumstellar medium.

"We really don't know much about Type Ia supernovae, and they're really important to our understanding of the universe," Reynolds said. Scientists use the fact that they all have similar brightness to calculate the distance of galaxies and to determine how much and how quickly the universe is expanding.

"Type Ia's also are the source of the majority of iron in the universe, and can give us a lot of information about its chemical history. A new class of Type Ia supernova has huge implications for our ability to understand the source of the elements that create our universe," he said. □



John Blondin and his simulation of a shockwave within a star about one second after the star begins to explode.

PHOTO BY ROGER WINSTEAD; SUPERNOVA SHOCKWAVE COURTESY OF JOHN BLONDIN

Moonrise over Antarctica's Bransfield Strait

NC State's global view on climate change

From North Carolina to the South China Sea, the ice pack of Antarctica to the jungles of Costa Rica, researchers at NC State are exploring the far-reaching effects of global climate change.

"Many of the Department of Marine, Earth and Atmospheric Sciences' (MEAS) research areas overlap with global warming and its effects," said John Fountain, department head. "Because this is such an important area, many of our faculty have specifically included global climate change in their work."

One of the challenges facing scientists is that the complex, and sometimes delicate, relationships and connections between earth systems were not fully understood to begin with—and now, many of these systems are undergoing profound changes.

On pages 8 through 15, we review several examples of the department's global warming-related research efforts.

Some may surprise you.

Antarctic research seeks to filter out the noise

There's a big difference between weather and climate. Basically, weather is what happens on a short-term basis – hours, days, weeks, months and even a few years. Climate is the trend over a much longer period.

It can be difficult to study global warming because climate's long-term trends are easily obscured by the short-term "noise" of weather.

Even in extreme climatic zones where weather is more stable and global warming is more obvious, detailed research must still account for the "noise."

"We think that ecosystems below the top 300 feet of water are suitable for tracking climate change because they are insulated to a large extent from seasonal noise," said Dave DeMaster, professor and leader of a three-year research project on the continental shelf in the West Antarctic Peninsula region. Also participating in the project are Carrie Thomas, research assistant professor and co-principal investigator, and three graduate students.

Currently, there is little information about carbon cycling and bottom-dwelling life in this area. The research project will provide baseline information so that changes, such as those responding to global warming, can be monitored. In fact, bottom dwelling life may provide a more accurate view of what's happening across the globe, because they are so efficiently protected from the effects of short-term trends and events, said DeMaster.

Climate warming will reduce the duration of winter sea-ice cover in the Antarctic Peninsula region, which will alter the local ecosystems and may even diminish bottom water formation in this area. Sponsored by the National Science Foundation, the project includes three research cruises. The research team will evaluate a broad range of ecological and biogeochemical processes.

An added feature of the research project is a Web site provided for high school students. It will offer Antarctic-based, climate change-related information, examples and opportunities to communicate with researchers in the field. □

PHOTOS THIS PAGE COURTESY OF DAVE DEMASTER

Faculty member Carrie Thomas and graduate student Pam Price are shown sampling sediment cores from the Antarctic continental shelf. The measurement of organic carbon contents in the sediment and rates of microbial activity provide important information about how the seabed is responding to seasonal changes in primary production and long-term climate variations.

How fast can the ocean rise?

Climate change raises important questions about the rise of the oceans. Will the sea level rise slowly enough that societies can adjust to them? How fast could the sea level rise during the next 100 years?

Research shows that under current conditions, the average rate of sea-level rise is about 3 mm per year. Will this rate continue?

Using seismic equipment and coring devices to study sediments on the shallow continental shelf in the western Pacific marginal seas, Paul Liu, Dave DeMaster and their colleagues are trying to answer these questions.

"The past is the key to the future," said Liu, assistant professor. More research is needed, but there are indications that when the ocean has risen very rapidly in the past, it has happened in spurts.

"Sedimentary and coral reef records have shown there were at least five rapid sea-level rising events during the last 20,000 years," Liu said. "The maximum rate of the sea-level rise reached up to 50–70 mm per year, and lasted 200–300 years, which caused extensive flooding and damage to the coastal zone."

"If these events happened in the recent past, they could happen again in the near future," said DeMaster, professor.

This is important because it has implications for coastal residents. Future sudden rises may not give coastal communities time to move homes and businesses farther inland, and they may be at greater risk for storm-related flooding.

COURTESY OF PAUL LIU

Paul Liu checks his Chirp Sonar System on the deck before sailing out from Keelung, Taiwan.

In addition, barrier islands, like those of North Carolina, may not be able to migrate landward and may become inundated. □

Listening to the ice

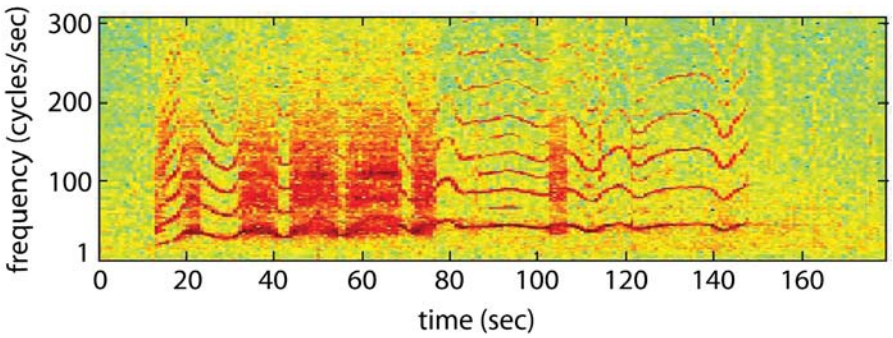
Perhaps the image most people visualize when they hear about global warming is ice breaking off glaciers into the ocean.

Scientists have monitored ice lost from glaciers and surface ice packs for years – it was one of the first signs that something was amiss climatologically. Now we're seeking better ways to monitor it.

Del Bohnenstiehl, an assistant professor who specializes in marine geology and geophysics, is in the early stages of developing a new way to listen to what the ice is telling us – literally.

"Hydrophones – underwater microphones – that are moored around Antarctica can be used to monitor ice breakup and movement," he said. "Ice-generated sounds can help us track large icebergs."

COURTESY OF DEL BOHNENSTIEHL



Visual representation, or spectrogram, of an ice-generated sound recorded by an underwater microphone deployed near the Antarctic Peninsula. The color scale reflects the amplitude of the sound, with warmer colors indicating times and frequencies with the greatest acoustic power. The banded, or harmonic, character of these signals indicates resonance within the ice mass—much like an organ pipe or vibrating string.

The overall level of ice-related noise may show a long-term correlation with the rate of ice breakup, he explained. If so, this remote sensing-ability would prove useful in an inaccessible environment hostile to humans.

In addition to its relevance to climate change, ice breakup can increase ocean noise, which can negatively impact sound-sensitive marine mammal populations. Bohnenstiehl seeks to learn more about this, as well. □

Water woes in the birthplace of hurricanes

Every summer, as eyes turn to the Atlantic Ocean for a six-month hurricane watch, Fred Semazzi looks farther east, to West Africa and the highlands of Ethiopia.

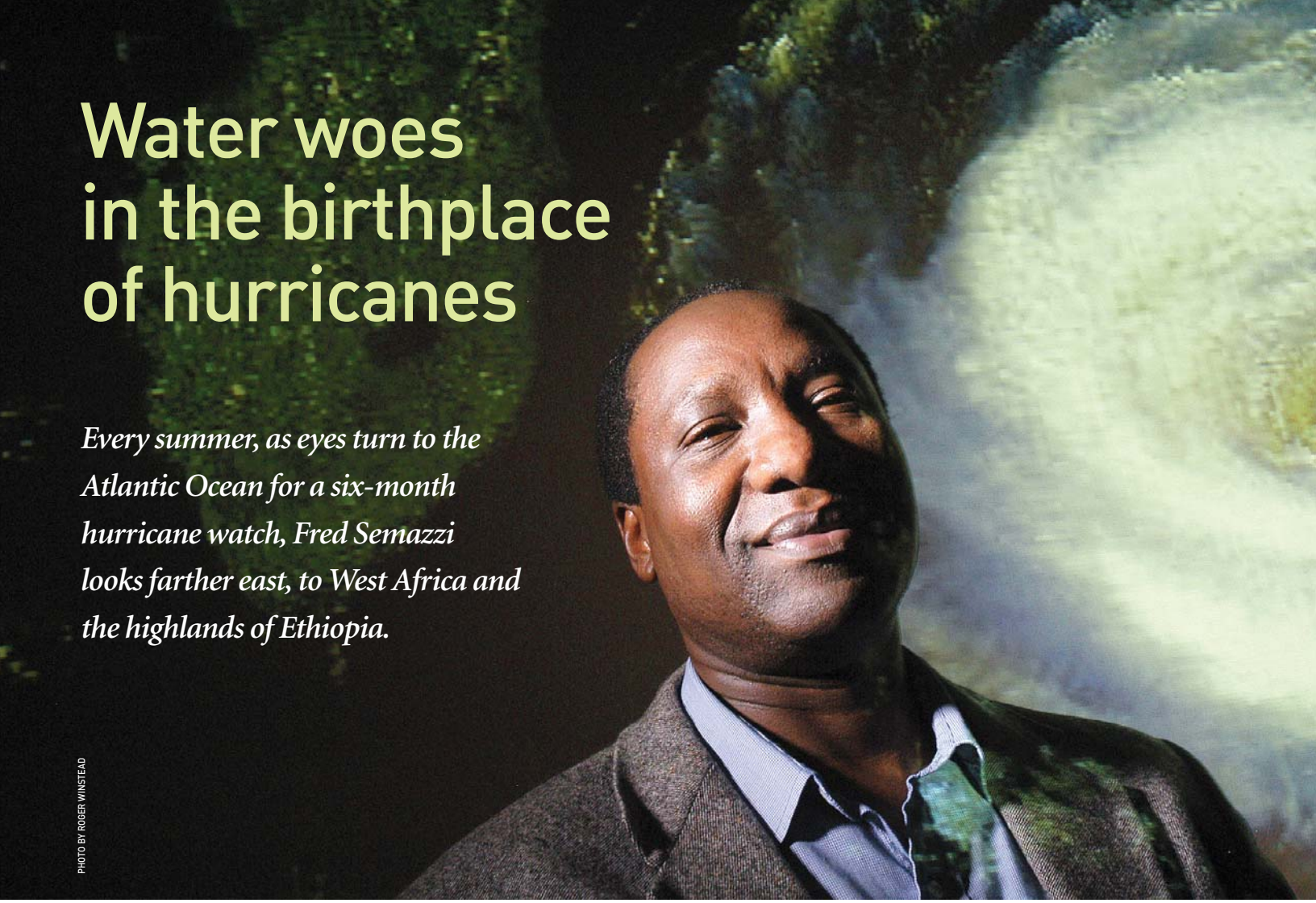


PHOTO BY ROGER WINSTEAD

In Africa, said Semazzi, wave-like disturbances in the weather could provide clues as to how tropical storms subsequently form in the Atlantic.

As part of a five-year research project funded by the National Oceanic and Atmospheric Administration Educational Partnership Program, Semazzi is using computer simulations to help forecasters better understand the genesis and evolution of hurricanes and improve climate prediction models.

"There may be linkages back across the Indian Ocean," he said. "Weather is global, and one small change on one side of the world could have widespread effects." Hurricanes represent only a part of his research, however.

Semazzi models the role of regional climate on the Nile River basin's water resources. For various reasons, international agreements – and the latest plans to revisit the sharing of the Nile's waters – do not adequately take into account the role of climate change on the present and future seasonal rainfall, he explained.

International treaties are based on diverting or sharing the Nile's water, and Semazzi's computations show the river's total volume dropping over time. "This could further destabilize the area," he said.

Semazzi is very familiar with political instability, having grown up in Uganda during the reign of dictator Idi Amin. Escaping his homeland was the reason he became a meteorologist – he had to choose an academic major that wasn't offered in any college in Uganda. He received his bachelor's, master's and PhD in meteorology from the University of Nairobi in Kenya. Today, he is a professor with dual appointments in the departments of Mathematics and Marine, Earth and Atmospheric Sciences.

His recent research indicates that a large area of Eastern Africa has experienced an alarming decline in rainfall of up to 20 percent during the past 20 years. This area includes Lake Victoria – one of the two sources of Nile waters.

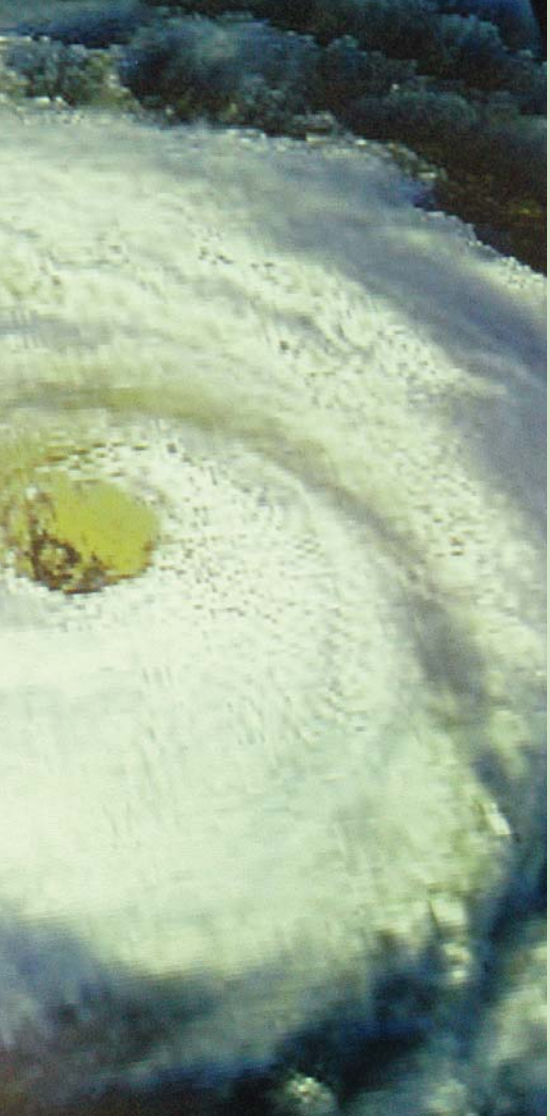
If this trend continues, there could be devastating implications for the social-economic fabric of the Nile basin countries.

"One of the major goals of my research is to contribute to the search for a comprehensive solution to the growing threat of an international water crisis in the Nile basin by clarifying the contribution of global warming, and subsequent climate change, to the regional water problem," Semazzi said.

Given weather's global nature, Semazzi and other meteorologists turn to high-performance computing to make predictions about year-to-year climate variability and change. Temperature, humidity, wind circulation, vegetation and other variables are fed into algorithms, and millions of calculations are performed to show changes that will occur over a few days for short-term weather forecasts – or many years for long-range climate projections.

"We get solutions at many discrete spatial points for as complete a picture as possible," Semazzi said. "But we can never have a climate model forecast for every location over the entire world because of computer limitations and gaps in the observed climate data."

Much of Semazzi's work is funded by the U.S. Department of Commerce and the National Science Foundation – both interested



in how climate affects various industries. For simulations of potential climate changes years from now, he factors in human actions, such as deforestation or increased greenhouse gas emissions.

"Long-range models are really more projections than predictions," he said. "Some dire projections may never come to pass because society may respond with remedial actions."

Semazzi noted that NC State has all the necessary ingredients to be a leader in providing the innovative training and mentoring needed to produce the kind of diverse, globally engaged scientific workforce needed to tackle global warming.

"Society needs future researchers and faculty who, in a collaborative environment, will conceive, develop and implement groundbreaking research to address the broad range of interdisciplinary, ethical and societal issues in climate change science," Semazzi said. □

–Adapted from NC State's Results *magazine; Matt Burns, writer*

Watching the clouds

How often do we look overhead and think about what the clouds really mean?

Sandra Yuter, assistant professor, thinks about clouds quite a bit. In fact, she was lead author of a report on aerosol pollution impacts on precipitation for the World Meteorological Organization. The report concluded that aerosol pollution can affect the amount, spatial and temporal distribution of clouds, but its impact on precipitation was inconclusive.

Clouds are known to play a major role in climate through their direct interactions with solar radiation. Precipitation from clouds is overwhelmingly the most important mechanism in replenishing ground water and completes the hydrological cycle. Changes in either the amount or the spatial and temporal distributions of precipitating clouds may have dramatic impacts on climate and society.

"There are complex interactions among environmental and meteorological parameters, aerosols, and cloud microphysics and dynamics," said Yuter, whose focus is physical meteorology. "This makes it difficult to establish clear causal relationships between aerosols and precipitation, or to determine signs of changes in precipitation patterns."

Yuter's Cloud and Precipitation Processes and Patterns research group is examining the characteristics of low clouds and the effects of aerosols on precipitation using satellite, radar and other data sets. □

Learning from the past

Geologic evidence can reveal a lot of information about climate changes that happened millions of years ago. But what about the not-so-distant past?

Rock that takes millions of years to form can't tell us what happened only thousands of years ago – but the water within it can.

For example, eastern North Carolina lies atop many alternating layers of sandstone, limestone, clay and silt. The sandstone and limestone layers function as aquifers and contain groundwater that has flowed slowly through the rock from higher elevations. Eventually, after tens of thousands of years, this groundwater reaches the coast. From there it flows seaward, ultimately seeping into the ocean.

"By studying concentrations of certain gases dissolved in ancient groundwater, we can estimate what air temperatures were when the groundwater entered the aquifer system," said David Genereux, professor of hydrology, who is working with student Casey Kennedy on a paper about their research. "Also, carbon-14 dating of the groundwater can provide an age to go along with the temperature estimate."

While the work was done to better understand groundwater flow, the results revealed a significant increase of about 7.5°C in the state's ambient air temperatures since the last glacial period. This increase is of an intermediate level between other warming estimates, also based on dissolved gases in ancient groundwater, from Maryland and Florida.

This kind of research introduces opportunities to explore more paleo-climate information hidden in groundwater. There are suggestions that groundwater could even contain clues indicating the season during which it entered the aquifer system, and the changing contribution to groundwater from cyclones. □

COURTESY OF DAVID GENEREUX

Doctoral student Casey Kennedy (MS '04) prepares to collect groundwater samples from a well in a deep NC Coastal Plain aquifer. Measurements of carbon-14 in the groundwater give an estimate of the time elapsed since the water entered the groundwater system, and measurements of dissolved trace gas concentrations allow estimation of the temperature at the time the water entered the groundwater system.

The phytoplankton effect

When a butterfly flaps its wings, does it set in motion a chain of events that ultimately results in a powerful tornado?

"The butterfly effect" might be a philosophical topic, but an NC State researcher has discovered that tiny phytoplankton in the world's oceans actually do set in motion a process that has implications for global climate. These one-celled organisms can influence clouds.

Nicholas Meskhidze, assistant professor, discovered a direct link between gases released from phytoplankton and cloud formation.

Meskhidze and colleague Athanasios Nenes of the Georgia Institute of Technology published their findings in the Nov. 2 issue of *Science Express*, an online preview of select articles from the journal *Science*.

Scientists have long thought that blooming phytoplankton play a large role in climate control due to their production of dimethyl sulfide, a chemical that produces aerosol particles when exposed to oxygen in the atmosphere. These aerosol particles in turn are responsible for the formation of low-lying clouds that reflect the sun's rays.

Aerosol particles assist in cloud formation by providing a surface for airborne water vapor to "stick" to so that it can form droplets.

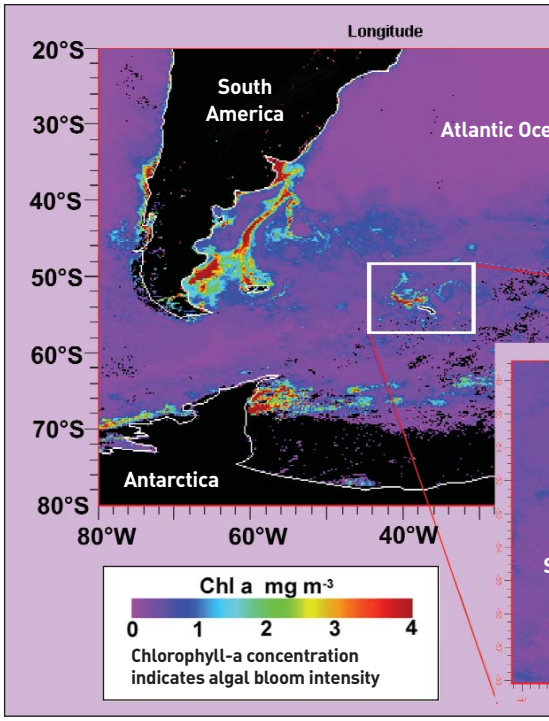
"In general, the more aerosols there are in the atmosphere, the more droplets will be formed within the cloud, and clouds with more droplets are 'brighter' and more effective at reflecting the sun's rays, leading to a cooling effect," said Meskhidze.

Meskhidze and Nenes had been studying NASA's satellite images of clouds and ocean color in the southern ocean, an area chosen primarily because of its lack of human-produced aerosol or water pollution.

"While looking at the satellite pictures, I noticed that cloud properties over large phytoplankton blooms were significantly different from those that occurred away from the blooms," Meskhidze said.

Meskhidze and Nenes used complex numerical models of cloud droplet formation to study the different ways in which phytoplankton may affect clouds. They discovered that enhanced concentrations of marine aerosols near the bloom region may be related to the bloom's production of *isoprene* gas.

When isoprene oxidizes, or combines with oxygen in the atmosphere, it creates secondary organic aerosols, or SOAs. These SOAs can "help" aerosols to nucleate into cloud droplets. Scientists have known that SOA from isoprene can affect clouds, but until now, this source was thought to be limited to terrestrial plants.



The team hopes that their study will lead to a better understanding of the role that ocean/atmosphere interaction plays in climate, and to more accurate global climate modeling. A significant uncertainty in climate models is the ability to predict how clouds respond to changing particle levels–whether they originate

The complexity of air quality

With so much attention on rising sea levels, melting ice and other dramatic effects of climate change, Yang Zhang focuses her research on something largely unseen—the quality of the air we breathe.

An associate professor specializing in atmospheric chemistry, she works to understand the relationships between air pollution and global climate changes, including effects of global/regional emissions and climate changes on regional/urban air quality, and effects of regional air pollution on the global atmosphere.

If it all sounds cyclical and inter-related, it is. That's the problem.

"To understand what to expect from the responses of air quality to climate change, we must first understand the complex two-way interactions between regional and global atmospheres," she said. "The impact of air pollutants on global environments cannot be adequately addressed without understanding issues at smaller scales, and vice-versa."

This research requires fully-coupled numerical models of meteorology, climate and atmospheric chemistry, some of which are being developed by her research group.

Zhang's work also involves estimating long-term impacts of global changes on urban and regional air quality over the next 50 years. □

Figure A – Isoprene Emissions

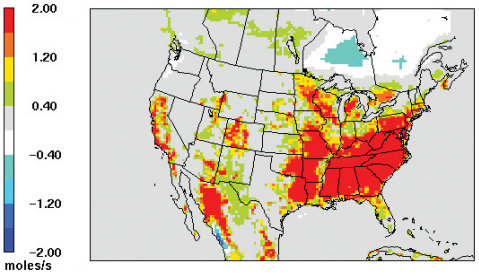
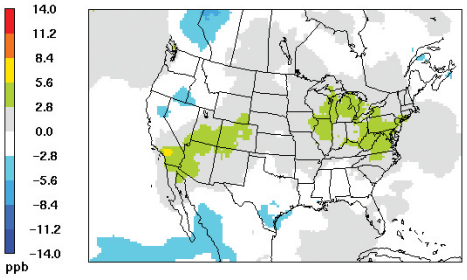
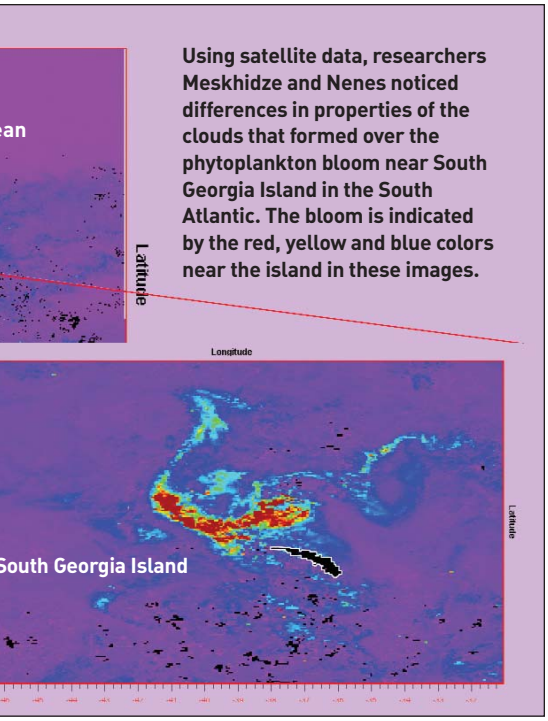


Figure B – Ozone Concentrations



These maps show predicted changes in *isoprene* emissions (A) and resulting ozone concentrations (B) from 2001–2051 in response to increases in temperatures and other climate variables. Ozone concentrations may increase up to 10 percent over large areas in the US by 2051.



COURTESY OF NICHOLAS MESKHIDZE

Using satellite data, researchers Meskhidze and Nenes noticed differences in properties of the clouds that formed over the phytoplankton bloom near South Georgia Island in the South Atlantic. The bloom is indicated by the red, yellow and blue colors near the island in these images.

from air pollution or biological activity. This research revealed that marine biology can have a strong influence on oceanic clouds.

The role of phytoplankton in cloud formation, related to its isoprene production, could be a major factor in global climate–one that is not included in current models, and that seems to work in opposition to the many factors leading to global warming.

But can blooming phytoplankton save the earth from global warming? Maybe not, but according to Meskhidze's research, they do produce cooling effects through removal of carbon dioxide from the atmosphere, and radiation reflection by the clouds they produce.

"There is still a lot we need to explore to better understand the delicate balance in nature," said Meskhidze. "It will require the cooperative efforts of researchers from many different fields to identify the chemical components in these aerosols, to estimate the amounts of this and other potentially important gases emitted from the ocean, and to better characterize the effect of organics on cloud droplet formation." □

COURTESY OF YANG ZHANG

ISOPRENE *is a gaseous organic compound emitted from vegetation. Its emission rate is highly dependent on temperature and sunlight. Higher temperatures lead to higher emissions. It is an important precursor for ozone formation. Higher emissions of isoprene typically result in higher ozone episodes. It is used as an indicator of how air quality responds to climate change.*

Following the water

Deep in a lowland Costa Rican rainforest, David Genereux and his students take water samples from wells and measure stream flow. They also climb 30-foot towers to take precipitation samples, and sometimes have to work in mud and water to get the information they're after.

They're interested in both the water itself, and the carbon it contains.

Carbon dioxide is the primary greenhouse gas responsible for global warming. A key to understanding global warming is unlocking the secrets of nature's carbon cycle: transformations of carbon between different chemical forms, how it moves around in the environment, and how it is stored long-term in carbon "sinks." The ocean, which stores a large amount of carbon, is a carbon sink. Rainforests, because of the dense vegetation that absorbs carbon dioxide during photosynthesis, are carbon sinks …or are they?

Tropical rainforests play a significant role in the carbon cycle, but their effect on atmospheric carbon dioxide is unclear. Global warming raises more questions about this relationship.

Research shows that the optimal temperature for photosynthesis–the temperature at which it is fastest–may be lower than previously thought for some tree species. In a warming climate air temperatures may rise beyond these optimal temperatures, resulting in slower forest uptake of carbon dioxide. Warmer temperatures also increase the rate of decomposition of organic matter to carbon dioxide. These two factors mean that global warming could turn rainforests from carbon sinks into carbon sources, adding to the warming problem–and to the loss of rainforest–instead of helping alleviate it.

Genereux, professor and hydrologist, seeks a better understanding of this Costa Rican rainforest's carbon cycle, and how it can vary in response to differences in nutrient and water availability. This requires research into the chemistry of the water flowing into the forest's watershed, as well as the water flowing out.

Genereux's research in the rainforest at La Selva Biological Station is part of a multidisciplinary, multi-institution project funded through the Biocomplexity Program of the National Science Foundation. His work has shed light on an interesting feature of this jungle's carbon cycle.

"In addition to the input of carbon dioxide from the atmosphere, this rainforest receives major inputs of carbon dioxide from below, dissolved in deep groundwater that seeps upward to streams and wetlands," he said. "The carbon isotopes indicate that this carbon dioxide likely results from magmatic activity within the earth's crust."

Costa Rica is located in a volcanically active area, as are many other rainforests around the globe. Some of this carbon goes into the atmosphere, some leaves the watershed via stream flow, and some may be taken up by plants. Genereux wants to know how much.

"The hydrogeologic transport of carbon is another factor in the rainforest carbon cycle," he said. "We need to understand the entire system before we can understand its response to climate change." □

COURTESY OF DAVID GENEREUX

Michael Jordan (BS Geology '00, MS MEAS '03) stands with an automated water sampling device, on a metal catwalk at a stream sampling site at La Selva Biological Station in Costa Rica. The device collects stream water samples every 1–2 hours during storms, for use in estimating stream export of chemicals, including dissolved organic carbon, from the rainforest watershed during storms.

What does climate change really mean for North Carolina?

Ryan Boyles is extension assistant professor in the Department of Marine, Earth and Atmospheric Sciences, NC State Climatologist, director of the State Climate Office, and a member of the NC Legislative Commission on Global Climate Change. Although many questions remain, he provides an overview of what local effects North Carolinians could expect from global warming, and reviews challenges we already face.

PHOTO BY ROGER WINSTEAD

Ryan Boyles

The global climate models used to simulate global temperatures do a fairly good job of simulating past global temperatures, so scientists have some confidence in future forecasts of global average temperature. However, while these models work well on a global scale, they do not work well on a regional scale. Until there are models that provide good regional forecasts, scientists have low confidence in any future temperature forecasts for North Carolina. But global warming will still likely impact the state.

Will it get warmer?

The southeast has not experienced much warming over the past 100-plus years. Most southeastern states, including North Carolina, have seen an overall flat trend in annual *average* temperatures. However, we have experienced local warming in urban areas, most likely due to changes in local land-use patterns and general urbanization. Since the mid-1970s, we have seen an increase in annual average temperature, but the 1960s and 1970s were relatively cool. But again, we don't have models that can provide good regional forecasts, so we cannot say with certainty what temperatures we will see in North Carolina.

Recent changes in the Arbor Day tree hardiness zone map were based on *minimum* temperatures from 1991–2005, which were indeed much warmer. Minimum temperatures are the one measure in which we've seen a widespread, increasing trend in North Carolina. Previous USDA maps included data from the 70s, a cooler period, which are excluded in the new Arbor Day map. However, many horticulturists have told me they are not recommending the new Arbor Day map.

The National Climatic Data Center uses a 30-year period to define climate normals.

What about sea level rise?

The largest impacts will be associated with sea level rise. The sea level along the coast has been rising over the past century and is expected to rise one to two feet in the next 100 years. This will likely influence the barrier islands and immediate coastal areas, but there are still many questions about how much coastline may be lost. Substantial monitoring of local sea level rise and impacts is needed.

Regardless of sea level rise, coastal development is a point of environmental and economic concern. How we live, work and play along our coast is an issue we must face even without sea-level rise. A rising sea level will only exacerbate an already challenging issue.

College participates in campus global warming activities

NC State has sponsored several recent events that focused attention on the issue of global warming from a variety of perspectives. PAMS and its Department of Marine, Earth and Atmospheric Sciences (MEAS) were involved in some of these activities.

In response to reports issued by the United Nations' Intergovernmental Panel on Climate Change (IPCC), NC State hosted, "Global Climate Change: Interdisciplinary Responses."

The three-day February symposium came shortly after the IPCC concluded that global warming has begun, that it is very likely caused by humans, and that the problem will continue for centuries. The IPCC warned that immediate action must be taken to prevent harmful consequences.

The symposium featured a lecture by Elizabeth Kolbert, staff writer for *The New Yorker* and author of the book, *Field Notes from a Catastrophe: Man, Nature, and Climate Change*. The book chronicles Kolbert's global travels and conversations with scientists and politicians in an attempt to understand the global warming debate.

A second lecture, co-hosted by MEAS and PAMS, featured David Archer, a computational ocean chemist at the University of Chicago, and author of *Global Warming: Understanding the Forecast*. The book provides a comprehensive overview of the issue in language aimed at the general audience.

About 200 people attended the lecture, which was followed by a panel discussion featuring MEAS faculty David DeMaster, Anantha Aiyyer, Nicholas Meskhidze, Yang Zhang and Daniel Kamykowski.

In March, Ralph Cicerone, president of the National Academy of Sciences and well-known researcher on atmospheric chemistry and climate change, presented the 2007 Harrelson Lecture, "How Humans Can Cause Global Climate Change." Cicerone's work has been lauded for helping scientists better understand greenhouse gases, ozone depletion, atmospheric cycles and other elements of the climate system.

Also in March, Waleed Abdalati, head of NASA's Cryospheric Sciences Branch at the Goddard Space Flight Center, spoke as part of NC State's Millennium Seminar Series. He is one of the world's preeminent experts in climate change, overseeing NASA-funded research on glaciers, ice sheets, sea ice and polar climate with the goal of better understanding changes in the Earth's ice cover.

Abdalati also participated in a panel discussion on climate change in North Carolina at the NC Museum of Natural Sciences. Joining him were David Easterling of the National Climatic Data Center in Asheville, Fred Semazzi of MEAS and Stephen Culver of East Carolina University. □

Will there be more frequent/intense hurricanes?

There are climatological factors that produce years-long cycles of greater hurricane activity. We experienced an active period in the 50s and 60s, and we're experiencing one now. Some studies suggest that overall hurricane intensity and frequency may increase with a warmer global climate. Hurricane intensity is directly linked to ocean surface temperatures, which are expected to continue rising. However, other studies suggest we have not seen any overall increases in intensity and frequency in the past 100 years, and still others suggest that other factors, including increased wind shear, may prevent much or any increase in hurricane intensity or frequency.

Either way, North Carolina is very sensitive to hurricanes. We have many challenges associated with these storms even without global warming–again, global warming will likely only complicate our current situation.

Will we have a shorter winter?

Trends over the past 30-plus years suggest that winter is becoming shorter, as measured by the number of days between the first fall freeze and last spring freeze. But there are many factors and complications in the historical and future climate signals that prevent any confident conclusions.

Will we have less snow?

Snowfall is not very rare in North Carolina, but it doesn't happen every day, either. It takes the right set of ingredients for snow here. A possible scenario is that snow will still fall, but the zones of more frequent snow may shift further westward to higher elevations.

Will we have increased droughts? Floods?

Possibly–it is thought that precipitation, especially in the warm season, would become more variable. There would be more dry days, and when it did rain, it could be more intense. However, this is very difficult to see in the historical data, and models used to predict future precipitation have very low confidence.

AVAILABILITY AND MANAGEMENT OF OUR FRESH WATER RESOURCES IS LIKELY THE BIGGEST CHALLENGE WE WILL FACE IN THE NEXT 100 YEARS—AND THAT CHALLENGE IS COMPLICATED MORE BY GLOBAL WARMING.

But North Carolina faces challenges with drought and flooding today–even without climate change. With increasing population, we are placing new stresses on our fresh water supplies. Indeed, availability and management of our fresh water resources is likely the biggest challenge we will face in the next 100 years–and that challenge is complicated more by global warming.

Recent efforts have reduced the risk of large river flooding by removing property from flood plains, but there is increasing risk of urban and street flooding as we continue to grow our cities and suburban areas.

Will North Carolina's climate become like that of central or south Florida?

Not likely, if for no other reason than we will continue to have consistent rainfall throughout the year. Central and southern Florida, in contrast, have distinct wet and dry seasons.

PHOTO BY SALLY RAMEY

The State Climate Office collects data through environmental monitoring stations located across the state, as well as stations operated by other agencies. Here, a student does routine maintenance on equipment at a station on university property.

The bottom line

While global warming will likely impact North Carolina through sea level rise, and possibly impact the state in many other ways, North Carolinians face very important weather and climate challenges already. More research is needed–clearer guidance will come with increased monitoring of our environment. Environmental data collection is the starting point for all future research and improvements in both short-term and longer-term forecasts. □

Focusing the view

It is natural to wonder how global warming will affect the area in which one lives. At the moment, it's hard to say.

"Although global warming is a global issue, its impacts are regional and non-uniform from region to region," said Lian Xie. "But there aren't good models for this scale."

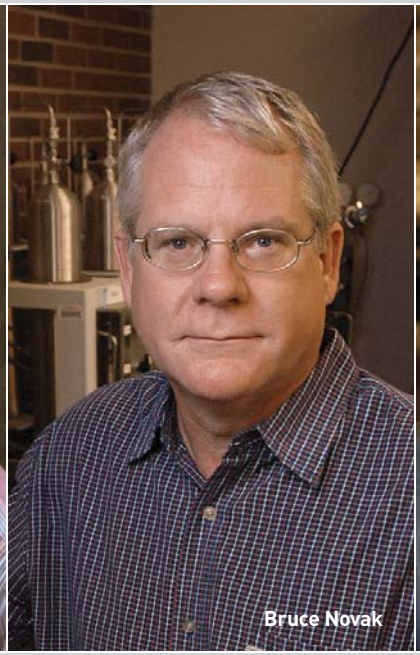
Professor Xie specializes in the development of climate and meteorological computer models. He is using regional climate models and statistical methods to scale down the effects of global climate change to regional and local scales.

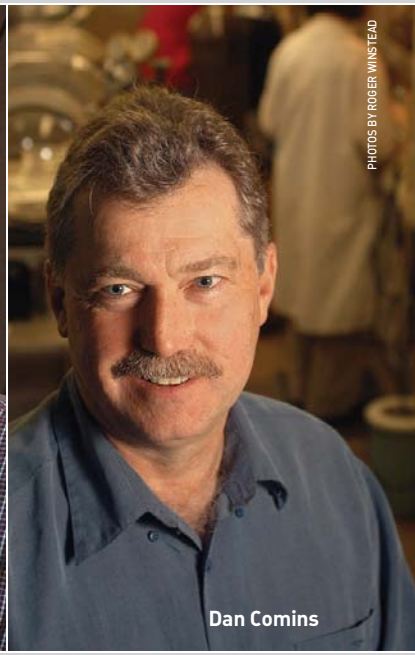
"Information at this scale will be more meaningful to the public, and more useful to officials concerned about long-range planning," he said.

Xie's research includes assessment of the effect of global warming on the activity of Atlantic hurricanes and Pacific typhoons, as well as the effect of global warming on East Asia monsoons. □


Jon Lindsey


Stefan Franzen


Bruce Novak


Dan Comins

PHOTOS BY ROGER WINSTEAD

Chemistry dominates recent patent awards

Discoveries at NC State fuel the economic engine of North Carolina and the nation. In fact, NC State is ranked as one of the best when it comes to transferring technology to the public. In 2006, IEEE, the world's largest professional technology association, ranked NC State ninth in the nation for universities with the most influential–and potentially most lucrative–patent portfolio.

Each year, NC State honors university inventors who have received U.S. Patents with an awards banquet and ceremony. This year, the Chemistry Department reigned supreme.

Chemistry faculty were named inventors on 11 of the 33 U.S. Patents issued to NC State in 2006. Professors Dan Comins received five, Jon Lindsey received four, Stefan Franzen received one, and Bruce Novak also received one.

Their achievement earned each a commemorative U.S. Patent plaque, presented at the 18th Annual Inventors Awards Luncheon and Ceremony in April.

Their patents cover a wide range of areas. Comins' patents relate to new chemistries that are useful for producing novel nicotine derivatives. Such compounds have potential as new drug candidates for the treatment of neurodegenerative and psychiatric disorders.

"We would like to understand charge propagation under control by light," said Franzen about his work. "There is growing interest in the use of transparent semi-conductors in a variety of applications including sensing, information technology and even energy production. This invention is a demonstration of a novel set of optical properties that provides new applications for known conducting metal oxides."

Novak's work involves synthesizing polymers, or plastics, with a high degree of control over their structures. Controlling the structure lends better properties to the material such as strength, durability and chemical resistance.

Lindsey's patents are related to his work in molecular data storage, which may lead to smaller, faster and far more powerful computers and other applications.

Because NC State benefits from income generated by patents obtained by faculty, the university and its students share in successful innovations. From 1997-2006, NC State collected more than $40 million in royalties from technology licensed to outside companies–money that is shared with inventors and invested in new intellectual property.

Those activities led the Association of University Technology Managers to rank NC State ninth in the nation among all universities for cumulative active licenses in 2007.

NC State spun out six start-up companies in 2006 based on technologies developed at the university. North Carolina's economy benefits when discoveries ignite technologies that lead to new products, new companies and jobs. □

EACH YEAR, NC STATE HONORS UNIVERSITY INVENTORS WHO HAVE RECEIVED U.S. PATENTS WITH AN AWARDS BANQUET AND CEREMONY. THIS YEAR, THE CHEMISTRY DEPARTMENT REIGNED SUPREME.

NC State "upstarts" shake up hurricane season forecasting

When graduate student Tingzhuang Yan prepared to speak to an audience of meteorologists, climatologists and other scientists at the 2006 American Meteorological Society Tropical Cyclone Conference in Monterey, California, he knew he was about to create a stir.

The 2005 season had seen a record-breaking 28 named storms, including Katrina, which devastated the New Orleans area.

All available data indicate a trend toward an increase in the number and severity of tropical storms, much like the active seasons of the 1940s and 1950s. And following the 2005 season, it was not surprising that other research groups involved in hurricane seasonal forecasting, including the famed Bill Gray group at the University of Colorado, predicted another very active season in 2006…

…except the research team at NC State.

Yan, a member of the NC State team, shocked the audience with a very different forecast—the 2006 season would be unusually mild, with only five or six hurricanes, one or two of which would strike the coast.

Other teams had to alter their forecasts as the mild season progressed, but NC State's forecast held firm.

"There was definitely some skepticism, and even some snickers in the room," said Len Pietrafesa, who was sitting on the front row near Gray and other luminaries in the field.

"We were definitely taking a chance," said Lian Xie, Yan's advisor. "All of the big names were predicting an active season."

The 2006 research team included Xie and Pietrafesa, both professors in the Marine, Earth and Atmospheric Sciences Department, along with Dave Dickey, professor in the Statistics Department, and Yan, whose PhD thesis was the basis for the 2006 forecast.

The team based its forecast on a new method for selecting important predictors. The team was not only able to forecast the number of storms, but also the number that would make landfall in certain areas.

Specifically, the team found a 100-year trend indicating a relationship between the number and severity of storms forming in the Atlantic and the difference in sea surface temperatures between the North and South Atlantic (see figures at right). In fact, this temperature differential also seems to play a role in the chances of these storms striking the East Coast.

"When the tropical waters in the North Atlantic are warmer than normal, and the tropical waters of the South Atlantic are cooler than normal, there will be a very active season," said Xie. This is the pattern the research team saw in 2005, but the temperatures in the North and South Atlantic were essentially equivalent in 2006, indicating a mild season.

The team's forecast went largely ignored until later in the season. Other teams had to alter their forecasts as the mild season progressed, but NC State's forecast held firm. By the end of the season, it became clear that the "upstarts" at NC State had produced the most accurate forecast.

This resulted, of course, in lots of media attention at the end of the 2006 season. And before year's end, NC State began receiving inquiries about when the 2007 seasonal forecast would be available.

Such research is a work in progress. There are many complex factors that can be fed into models for greater accuracy. But which factors? There are many from which to choose, so the research team is now pursuing additional strategies.

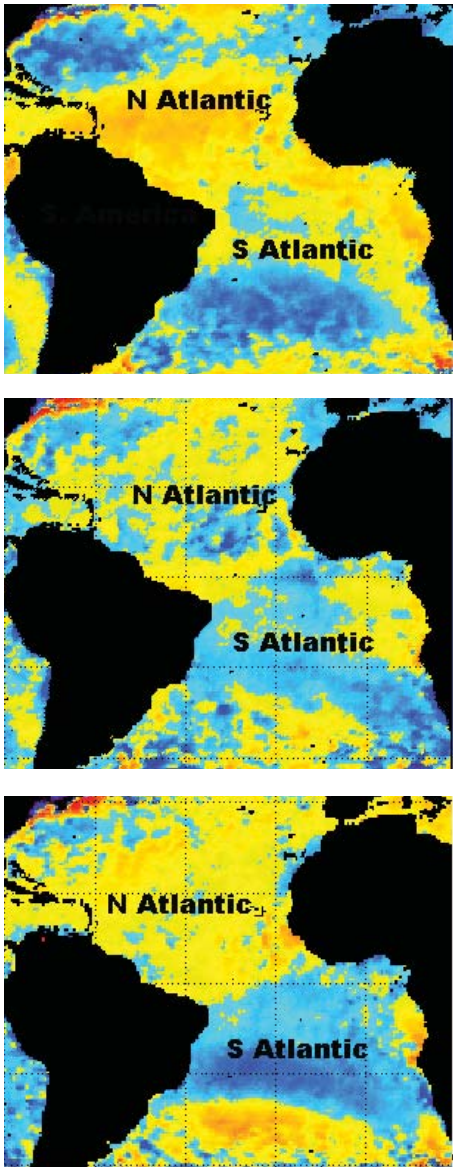
In April, Xie and graduate student Elinor Keith issued a forecast for an active season, with the possibility of 12–14 named storms forming in the Atlantic Basin, which includes the entire Atlantic Ocean, the Gulf of Mexico and the Caribbean Sea. Of those named storms, eight or nine may become hurricanes, four or five of which have the potential to become major storms of Category 3 or higher.

They suggest that the Gulf of Mexico is most likely to see storm activity this year, with a higher-than-average probability of two or three hurricanes forming in the Gulf Basin, and one or two likely to make landfall. Closer to home, the southeastern coast may see between one and three named storms, with one or two hurricanes making landfall.

Pietrafesa's section of the team reported that there will be 16–18 named storms, with the likelihood of eight or nine becoming hurricanes and two or three making landfall on the Gulf Coast. Another two or three are predicted to make landfall along the East Coast.

All in all, the research indicates a very busy year. Batten down the hatches. □

COURTESY OF LIAN XIE



The 2005 season experienced a significant difference in sea surface temperatures between the warmer than usual North Atlantic (mostly yellow/orange) and the cooler than usual South Atlantic (mostly blue). The more mottled temperature pattern of the mild 2006 season indicated a less dramatic temperature difference. Note that the 2007 pattern is more similar to 2005, indicating an active season.

Dicky Morrison's excellent surprise

Anyone who lives in central North Carolina, or who attended NC State within the last 26 years, is probably familiar with Greg Fishel, chief meteorologist at WRAL-TV in Raleigh.

Dicky Morrison certainly is. A longtime "weather geek," Dicky is a big fan. She has religiously watched Fishel's forecasts for years.

"In our house, no one speaks while Greg is speaking," joked Dicky's husband, Bob. "We cannot proceed with dinner while he is doing the evening forecast, and we cannot retire until his 11 p.m. forecast."

While Dicky's devoted monitoring of the weather forecast may be the brunt of good-natured family jokes, Dicky's interest in meteorology has always been sincere. So, Bob decided to honor her hobby with a surprise, and engaged the help of the College.

One evening in January, Bob gathered the couple's two children and their families together for a large, private family dinner at the Cardinal Club in downtown Raleigh. While they were enjoying pre-dinner drinks, Dan Solomon, dean of the College, and Anita Stallings, executive director of Development and College Relations, "just happened" to wander in.

Because College officials participate in meetings with donors, research partners, alumni and others at various locations and times around Raleigh, it seemed perfectly normal that Stallings and Solomon would be at the club for "a meeting," spot the Morrisons and stop by to visit. Dicky didn't suspect a thing.

PHOTO COURTESY OF THE MORRISON FAMILY

Dicky Morrison, shown with Dean Dan Solomon, reacts to Greg Fishel's announcement that her husband, Bob, has established a meteorology scholarship endowment in her name.

The group socialized for a few more minutes.

Then Fishel walked in.

He was accompanied by Mike Trexler (BS '94 Meteorology, MS '97 MEAS), a former WRAL radio meteorologist.

The excuse for Fishel's presence was that, as chair of the State Climate Office advisory board, he was the one "meeting" with Solomon and Stallings. Dicky was very professional when introduced to Fishel and still did not suspect a thing.

A few moments later, Stallings spoke up.

"We're actually here tonight because we have an exciting announcement, and we want

PHOTO COURTESY OF THE MORRISON FAMILY

Gathered for the Morrison family dinner were (first row) Mandy Holt, Dicky Morrison, Bob Morrison, Michael Holt, (back row) Emma Holt, Ann Nelson, Robert Nelson, Brad Nelson, Trina Holt, Bill Nelson and Greg Fishel.

all of you to be the first to hear it," she said, turning toward Fishel.

Fishel then explained that in honor of Dicky's love for meteorology, Bob had established the Dicky Morrison Undergraduate Meteorology Scholarship Endowment.

Dicky, finally realizing that she had been set up, squealed, "Bob! Did you know about this? Bob?"

After the announcement and before dinner, Trexler, an alumnus of NC State's *a cappella* group, The Grains of Time, teamed with pianist Laura Young for a medley of weather-related songs. Both friends of the Morrisons, they performed, "They Call the Wind Maria," "The Sun Will Come Out Tomorrow," "Blue Skies" and others.

After some satisfied laughs, some personal remarks, and a few photos, the group enjoyed dinner together. Bob had thought of everything–the menu was based on a weather theme. Even the table's floral arrangements displayed flowers and greenery representing all four seasons.

This is only the second meteorology scholarship within the College, and because of growth in that program, the scholarship fills a critical need.

Morrison took advantage of his former employer's matching gift program – some corporations match their employees' charitable contributions even after they have retired.

"Because of our interest in supporting higher education, and specifically PAMS, I could think of no better way to honor Dicky's fascination with meteorology than through this scholarship," Bob said.

"I really can't believe this," Dicky said. "This is just wonderful!"

"Isn't it great when a plan comes together?" said Stallings. "It isn't every day that you can throw a surprise endowment party." □

Donors, College plan endowment surprises

In retrospect, we should have seen it coming. In the last issue of *Scope*, there was a story that explained how PAMS recently began holding endowment signing ceremonies. These events allow the College to personally thank the donor, and provide the donor with an opportunity to express their thoughts about the gift, the person they may be honoring by the gift, and what they hope the gift will accomplish.

"Many of our endowments were established in memory or in honor of someone special or inspirational to the donor," said Anita Stallings, executive director of Development and College Relations. "So we probably should have expected that donors would see the ceremonies as a way to surprise the person they wish to honor with an endowment."

Since January, PAMS has helped donors secretly spring the news onto three unsuspecting honorees. The story at left details the first surprise, which did not include signing the paperwork, but served the same purpose through the remarks and sentiments shared.

The next "victim" was David Haase, director of The Science House. He thought he was going to an evening meeting about fundraising and donor stewardship. But when he walked into the conference room, he found his wife, Jenny, and son, Glen, PAMS and university officials, coworker Sharon Schulze and refreshments waiting for him. Dean Dan Solomon delighted in taking away Haase's cup of coffee and replacing it with a flute of champagne.

Sharon Schulze, associate director of The Science House, had been so inspired by Haase's commitment to K–12 science and mathematics education that she established an endowment in his honor. The David G. Haase

PHOTO BY DENISE HUBBARD

Glen, David and Jenny Haase with Sharon Schulze

Endowment for The Science House will support the organization and its outreach programs, such as school demonstrations, student science camps and teacher worshops.

"I was so deeply touched," Haase said. "This is an incredible honor and a huge surprise."

The surprise almost wasn't. Haase showed up elsewhere in the building ahead of schedule and only luck prevented him from seeing his family arrive. They were quickly ushered to the conference room so he wouldn't run into them.

The third surprise happened during the spring luncheon for the PAMS Foundation board of directors. Board member and former foundation president Michael Peirson and his wife, Lee, had chosen to share their endowment signing ceremony with the board. Their endowment also will support The Science House, and Haase was there to participate in the ceremony.

Solomon explained the purpose of endowment signing ceremonies to the board. He described, with some glee, Haase's recent surprise before introducing him to speak about the Peirson's gift.

That's when Haase announced that the tables had been turned–the Peirsons were naming their endowment after Solomon, who was–quite satisfyingly–shocked by the news.

"Lee and I are grateful for the opportunity to say thank you in a small way so your name will forever be linked to The Science House," said Peirson.

Will the surprise endowment trend continue? Time will tell, but the College is happy to conspire with donors.

"It's a little challenging to plan in secret, but we're delighted to help donors with surprises if they feel it will make their endowment gift more meaningful," said Stallings. "And it's fun!" □

Dean Dan Solomon, Don Johnson, Ji Zhang and Bob Morrison

PHOTO BY SALLY RAMEY

PAMS honors Johnson, Zhang & Morrison

Family, friends and faculty gathered to see the College honor three individuals at its annual awards dinner, held at the Cardinal Club in downtown Raleigh.

PAMS honors Don Johnson as 2006 Distinguished Alumnus

W. Donald "Don" Johnson was selected as the College's 2006 Distinguished Alumnus. In addition to the College dinner, he attended a university event where each college's distinguished alumni were celebrated.

Established in 1990, this award recognizes alumni whose exceptional achievements in business, education, research or public service have brought honor and distinction to the College and NC State.

"Don is an esteemed alumnus of our College, a distinguished figure in his profession, and a leader at the highest levels of one of the world's most prominent, innovative companies," said Daniel L. Solomon, dean of PAMS.

Johnson was raised on a farm in Buies Creek, North Carolina. He attended Campbell University for two years before transferring to NC State in 1967. He graduated summa cum laude in applied mathematics in 1969, and went on to earn a master's degree in mechanical engineering in 1971, and a PhD in mechanical engineering in 1974.

He began his career with DuPont in 1974 at a plant in Kinston, and has been with the company ever since. He has held numerous positions in management, and has held key positions associated with several of the company's key product lines, including Dacron polyester, Tyvek and Teflon.

Johnson held corporate strategy and business development assignments at corporate headquarters in Wilmington, Delaware, before relocating to Geneva, Switzerland, where he had responsibility for the European Nonwovens and Advanced Fiber Systems businesses.

His other leadership posts have included national and international executive positions for Kevlar, DuPont Advanced Fiber Systems, DuPont Nylon in North America, Nylon Worldwide and DuPont Operations & Services. In 2004, he was named group vice president for DuPont Global Operations & Engineering, which consolidated all global operations and engineering into one unit.

Johnson was named to his current position in April 2006. He now serves as chairman and representative director for DuPont-Japan.

Johnson has played an active role in serving his community. He began this service during graduate school as an on-campus solicitor for the Wolfpack Club fund drive. He has held positions on the boards of directors for the Delaware Heart Association and the Delaware United Way. He has served his profession through director and chair positions with the American Manmade Fibers Association.

Always remaining close to NC State,

Johnson has served as vice president, and currently as president, of the NCSU Physical and Mathematical Sciences Foundation board of directors, and has been a member of the board since 1998. He also is a member of the Chancellor's Circle and has given generously to programs of the College.

Ji Zhang receives 2006 Medal of Achievement

Ji Zhang of Basking Ridge, New Jersey, received the 2006 PAMS Medal of Achievement. The award recognizes alumni of the College who have excelled through their chosen profession or public service, and proven themselves destined to make a significant impact on science, government, education, business or industry.

He received his BS in mathematics and MS in mathematics and probability from Peking University in Beijing, China, in 1982 and 1985.

After receiving his PhD in statistics from NC State in 1990, Zhang spent 13 years as a biometrician and senior director of biostatistics at Merck Research Laboratories. While there, he managed the statistical support for the successful development and marketing of several compounds. And he secured an ongoing fellowship program from Merck for NC State's Statistics Department.

Zhang left Merck in 2003 to join the world's third largest pharmaceutical company. As vice president of biostatistics at France-based Sanofi-Synthelabo Research, he was responsible for world-wide biostatistical and programming support for discovery, preclinical and clinical research. His title changed to vice president of biostatistics and programming in 2004 when the company became *sanofi-aventis*.

Most recently, he was promoted to vice president of international clinical operations and international development, which includes responsibility for about 3,000 researchers and support personnel in R&D centers in 28 countries, and clinical operational activities in many more.

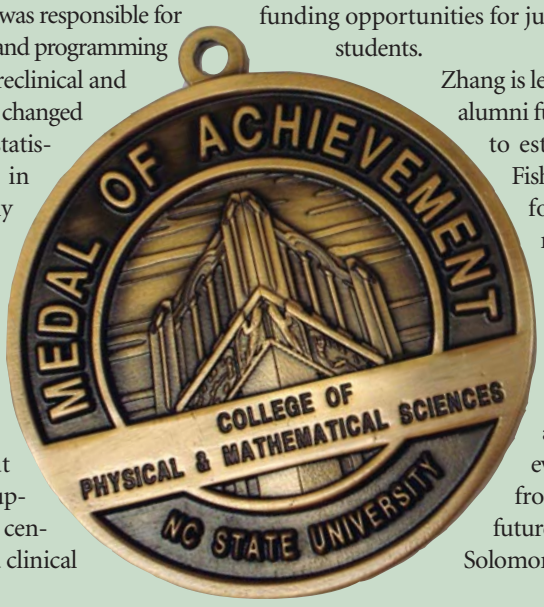
Zhang is extensively published on statistical, epidemiological methods and applications, and medical and clinical research. The most common topics of his work involve clinical trial development related to asthma research.

He has served his field as referee of several journals, some for many years. He has spoken at numerous conferences and meetings, and has served as chair or organizer for invited sessions. He is a member of several societies, such as the American Statistical Association and Biometric Society, and has contributed his time and talents to many committees within those organizations.

Zhang has maintained a close relationship with the Statistics Department. He always attends department socials at the Joint Statistical Meetings, and provides advice for the department. Whenever he receives an honorarium, he donates it to the department, with a match from his company. He has hired a number of NC State students both at Merck and now *sanofi-aventis*. He always strives to improve relationships between industry and academia, and looks for funding opportunities for junior faculty and students.

Zhang is leading a statistics alumni fundraising effort to establish the R.A. Fisher Professorship for the department.

"We're very proud of Ji, we're excited about his latest achievement, and we expect even greater things from him in the future," said Daniel L. Solomon, dean.



Each Distinguished Alumnus receives a handsome award at the university recognition ceremony and a special gift from the College. Recipients of the Zenith Medal for Service and Medal of Achievement receive medals, shown here smaller than actual three-inch diameter, displayed with a ceremonial ribbon in a special case.

Bob Morrison receives 2006 Zenith Medal for Service

Robert W. Morrison, Jr. received the 2006 Zenith Medal for Service, which recognizes alumni or friends of the college for distinguished contributions or advocacy that significantly advance the college's ability to make powerful impacts on science, the economy, the environment and the quality of human life.

"This award recognizes our College's greatest champions," said Daniel L. Solomon, dean of PAMS. "And there are few individuals who have championed our cause with as much determination, and over as many years, as Bob Morrison."

Morrison, a longtime senior executive with Burroughs Wellcome Co., has maintained a close connection with the college since moving to the area in the late 1960s.

Over the years, he served the Chemistry Department as visiting and adjunct faculty, and as a member of the department's board of visitors. A dedicated student mentor, he advised countless students over the years, many of whom made career decisions based on his counsel.

Morrison has been an enthusiastic advocate for the college, and was a vocal supporter of the need to provide updated laboratory facilities for students. The results are represented by the Marye Anne Fox Undergraduate Science Teaching Laboratory building, and a plaque in the Fox lobby that bears Morrison's name.

Morrison also obtained corporate funding for the Chemistry Department's first graduate student fellowships. After retiring, he served the college through short-term administrative assignments.

Morrison also established two scholarship endowments for the college. One has been supporting chemistry students since 1996. He recently established a meteorology scholarship in honor of his wife, Dicky, and her lifelong fascination with weather (see related story, page 18). □

Hunter establishes two statistics professorships


PHOTO BY DENISE HUBBARD

Dean Dan Solomon, Stu Hunter and Statistics Department Head Sastry Pantula

J. Stuart "Stu" Hunter has established two $1 million professorships in the Department of Statistics.

"Stu's generosity will enable the department to offer the J. Stuart Hunter Distinguished Professorship and the Gertrude M. Cox Distinguished Professorship," said Sastry Pantula, department head.

These are the first professorships established for the Statistics Department. The professorships will help the department recruit and retain preeminent faculty.

Hunter originally intended to endow only one professorship, using a matching fund incentive offered by the state legislature to encourage professorship endowments. However, he was surprised to learn that there was a double-match incentive available, meaning that he could endow two professorships instead of one (see related story next page).

"I was delighted that I was able to honor Gertrude Cox with a professorship housed in the department she built," Hunter said. "It is important that we remember her legacy."

Hunter's own legacy also is one of which NC State is very proud, explained Pantula.

"We are truly fortunate to house professorships named for two of our field's most prominent figures," said Pantula. "At NC State, we are always mindful of our department's history, and the impact of our graduates and fellow faculty on our profession."

> **"We are truly fortunate to house professorships named for two of our field's most prominent figures."**
>
> *Sastry Pantula*

Hunter's gift was celebrated at a dinner and endowment signing ceremony at Second Empire Restaurant & Tavern in Raleigh. Among those attending were Statistics Department faculty Pantula, Dave Dickey and Peter Bloomfield, retired faculty member Al Finkner, and department family members Vi Rigney and Julie McVay.

"The event brought together several of the world's most distinguished authorities in time series analysis," noted Dean Dan Solomon. "But the highlight of the evening was an original, humorous musical tribute to Stu in Gilbert and Sullivan style by our Development staff."

Inspired by a conversation with Hunter about Gilbert and Sullivan, Anita Stallings and Denise Hubbard performed, "I Am the Very Model of a Man Who is Statistical," rewritten by Hubbard and Sally Ramey just for the occasion.

Hunter received his PhD in Experimental

Belins establish flexible professorship

Jake and Betty Belin of Rancho Palos Verdes, California, were the first to take advantage of a unique double-matching incentive designed to encourage professorship endowments (see related story at right).

The Belins have been active supporters of the College for many years. Jake, a 1970 mathematics graduate, is president of Kern Oil & Refining Company. A vocal advocate for youth and education, he was named the PAMS 1993 Distinguished Alumnus.

In 2003, the Belins established a scholarship endowment for students from Florida, providing rare, out-of-state student support.

Their professorship also will provide a rare type of support–it may be offered in four of the college's disciplines.

"The Jacob and Betty Belin Distinguished Professorship will provide incredible flexibility in recruiting and retaining top-notch faculty in any of these disciplines," said Anita Stallings, executive director of Development and College Relations. "We are very appreciative of their continuing support, and this generous investment, which will allow us to compete more effectively with other institutions." □

Betty and Jake Belin

Statistics from NC State in 1954. He is professor emeritus, School of Engineering and Applied Science, at Princeton University. He has published extensively regarding the statistical design of experiments and industrial quality control, and has served as author and editor of several professional publications, journals and books. Hunter has received many honors on both the national and international level.

Hunter was the 2004 Distinguished Alumnus of the College of Physical and Mathematical Sciences. He also received an honorary Doctor of Sciences degree from NC State in 2006.

Hunter continues as an active consultant to industry and government, and is currently developing seminars for industry in conjunction with the NC State College of Textiles. He lives in Hightstown, New Jersey. □

Limited supply: Professorships 67% off!

Opportunities remain to establish $1 million professorships for $333,000 under a unique double match.

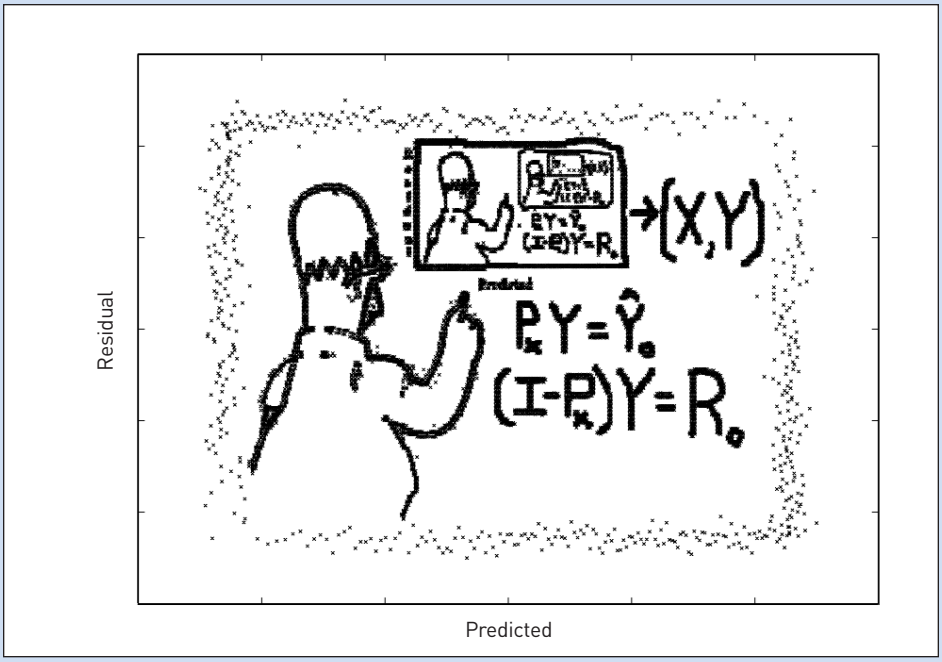
The NC State Legislature provides funds to the Distinguished Professors Endowment Trust Fund to match endowed professorship gifts on a 1:2 basis. This match, managed by the UNC Board of Governors, reduces the donor contribution for a $1 million professorship to $666,000.

However, the PAMS Campaign Committee allocated $2 million as an additional match. These funds were originally designated for endowment in any category of need that was unmet by the Achieve! Campaign for NC State. Using the funds as an additional match further reduces a donor's professorship contribution to $333,000.

The ability to establish a $1 million professorship at such a discounted level is an unusual bargain for donors and a bonus for the College.

Professorships are crucial for attracting and retaining outstanding faculty who in turn attract top students and motivate the next generation of scientists, scholars and policy makers.

While professorships require a minimum endowment of $1 million, they are not limited to that amount. Larger endowments provide faculty with more discretionary income. State matching funds provide up to $667,000 to encourage larger professorship gifts. □



D'oh! Homer Simpson in statistics class?

Say you're an aspiring statistician who has just spent hours trying to figure out the answer to a particularly thorny problem. As you plug the final numbers into the computer program you're running in order to confirm your analysis, an image takes shape on the screen ... Homer Simpson, working a problem on a blackboard. What would your reaction be?

For students of Dr. Len Stefanski, professor of statistics at NC State, it's usually more, "Whoa!" than, "D'oh!"

Stefanski has developed a method for hiding messages and pictures in data sets. These images only appear when a student or statistician correctly analyzes the data via regression analysis, a statistical process for studying how one variable depends on others.

His innovative approach to making statistical analysis fun was featured in the May edition of *The American Statistician*.

"Regression analysis is used in every scientific field," Stefanski said. "It's a way to describe how one variable depends upon other variables—for example, you can use regression analysis to discover how blood pressure is affected by cholesterol, weight, diet and other risk factors. Or how temperatures in different parts of the ocean might affect the number of hurricanes that occur in a given season."

When statisticians do regression analysis, they use computer programs to help them discover trends and variability within a given set of data. The programs plot the data as dots in an on-screen graph. A statistician looking at the relationship between height and weight, for example, would expect the general trend in the graph to be that weight increases with height—and that the majority of the dots in the graph would fall along that trend. However, there are always exception—people who don't fit the pattern or trend. These exceptions would show up as "scatter" in the computer model, or random dots on the screen.

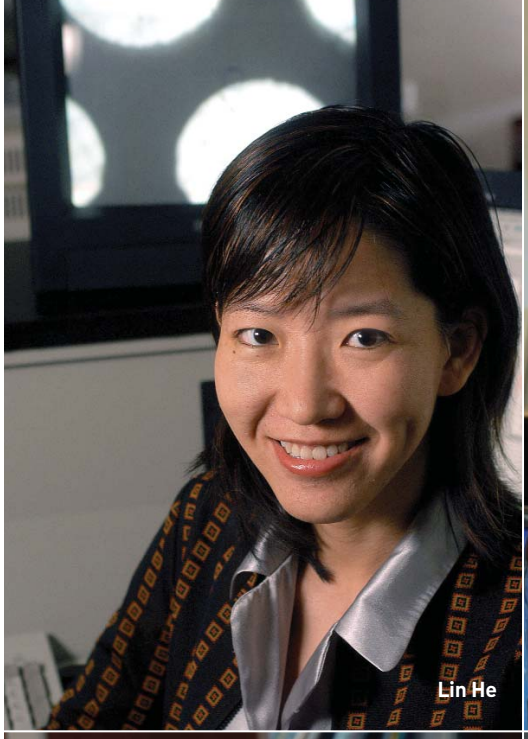
"The challenge for the statistician is to find the correct trend in a data set," Stefanski said. "If you've done the analysis correctly and extracted the trend from the data, then all you should have on-screen when you're finished is the random scatter, and I wanted to find a way to make the payoff for getting the right answer a bit more interesting for students."

Stefanski created a simple computer program that allowed him to "hide" images or messages in data sets. When a student successfully identifies and removes the trend data from the set, the message or picture is revealed in what is known as a residual plot. He has made the data sets available to colleagues and the public on his Web site, and will make the computer program he created available soon as well.

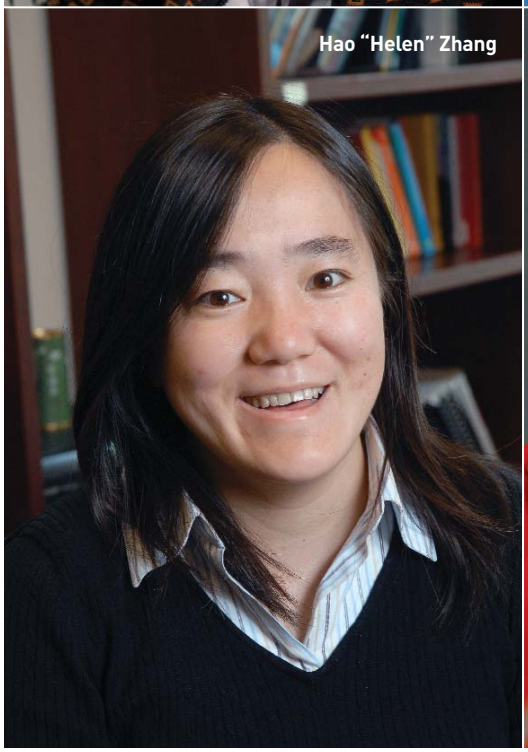
"It's not a terribly efficient means of encryption," Stefanski said. "But it certainly makes statistical analysis more visually interesting." □

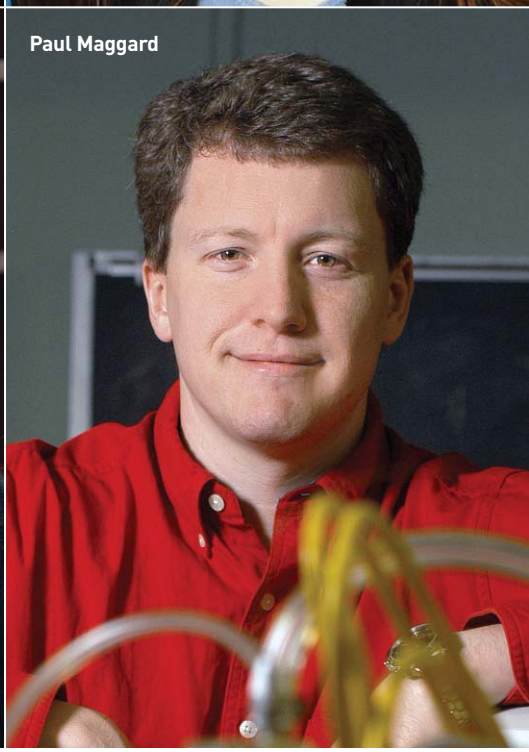
Four faculty receive NSF CAREER Awards

PHOTOS BY ROGER WINSTEAD


Lin He


Karen Daniels


Hao "Helen" Zhang


Paul Maggard

Four members of the PAMS faculty have received National Science Foundation (NSF) Faculty Early Career Development (CAREER) Awards.

The NSF CAREER Award is one of the highest honors given by NSF to young university faculty in science and engineering, and is intended to advance the development of their research and careers.

Karen Daniels, assistant professor of physics, received a five-year, $505,036 grant for her proposal titled, "State Variables in Dense Granular Materials." Her research focuses on how temperature-like variables or boundary compression impact the state of granular systems. Systems composed of granular materials can act like either solids or liquids. Improved understanding will someday impact processing industries, geotechnical engineering, and earthquake hazard estimation by providing diagnostics to measure the state of a granular system before it fails or jams.

Daniels received her bachelor's degree from Dartmouth College in 1994 and her PhD from Cornell University in 2002. She joined the NC State faculty in 2005.

Lin He, assistant professor of chemistry, received a five-year, $590,000 grant for her proposal titled, "Amplification by Polymerization in DNA Biosensing." This research focuses on developing a new generation of DNA biosensing technology, improving the efficiency and accuracy of these important medical diagnostic tools. Her research interests also include the development of nanomaterials-based mass spectrometric methods in metabolite detection and surface-based spectroscopic methods in membrane peptide studies.

She received her bachelor's degree from Peking University in Beijing in 1996, and her PhD in chemistry from Pennsylvania State University in 2000. She joined NC State in 2003.

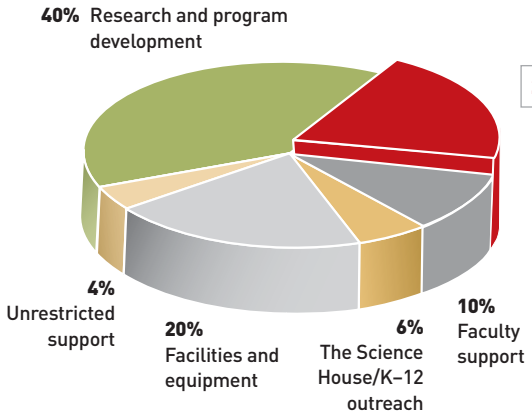
Paul Maggard, assistant professor of chemistry, has received a five-year, $500,000 grant for his proposal titled, "Synthesis of Multifunctional Hybrids of Reduced Rhenates and Related Systems." His research focuses on creating oxide/organic hybrid materials with an advanced structural flexibility and functionality that will allow scientists to access a wide range of new electronic and magnetic properties.

Maggard received his bachelor's degree from William Jewell College in 1995 and his PhD from Iowa State University in 2000. He joined the NC State faculty in 2002.

Hao "Helen" Zhang, assistant professor of statistics, received a four-year, $500,000 grant for her proposal titled, "Nonparametric Models Building, Estimation, and Selection with Applications to High Dimensional Data Mining." Her research focuses on statistical model building and variable selection, nonlinear function estimation, and high dimensional data analysis. The work has wide applications for information extraction, data mining, and other fields demanding massive and complex data analysis such as biological, medical and engineering sciences.

Zhang received her bachelor's degree in 1996 from Peking University in Beijing and her PhD from the University of Wisconsin-Madison in 2002. She came to NC State in 2002. □

Achieve! The Campaign for NC State



20% Undergraduate and graduate student support
Increasing endowment resources to support students is an important objective of NC State's $1 billion campaign. The article on page 4 highlights the impact of scholarships, fellowships and other endowments. At this time, PAMS is at 67 percent of its student support goal.

PAMS Campaign Goals	Endowment	Current Needs
Undergraduate and graduate student support $10 million will double the current level of support, providing resources to compete for talented students and meet financial needs	$ 6,500,000	$ 3,500,000
Faculty support $5 million will endow professorships to recruit and retain distinguished teaching and research faculty	5,000,000	
The Science House/K–12 outreach $3 million will create an endowment to provide permanent support for The Science House, and fund current teacher training and student science programs	1,000,000	2,000,000
Facilities and equipment $10 million will support modern instructional methods and technologies		10,000,000
Unrestricted support $2 million in flexible, current gifts will allow us to respond to exciting opportunities, urgent needs and unexpected challenges		2,000,000
Research and program development $20 million will enable us to conduct research and develop academic programs leading to discoveries and knowledge that enhance quality of life and stimulate economic development		20,000,000
Total	$12,500,000	$37,500,000

PAMS Campaign Needs **$50,000,000**

How to make a gift

You may remember how difficult it was to manage the expense of higher education. You may want to help today's students achieve their dreams.

The PAMS Foundation provides many ways to support students, faculty and programs of the College. Whether you want to contribute to an existing scholarship, support a departmental enhancement fund, make a memorial gift or consider support in other areas, our staff is available to help you explore the options.

To support existing funds

To contribute to a scholarship, fellowship or other fund, fill out our secure, online gift form at https://www3.acs.ncsu.edu/pams/ or mail a check to the PAMS Foundation, Campus Box 8201, Raleigh, NC, 27695. Make checks payable to PAMS Foundation and write the name of the fund on the "notes" or "for" line.

If your employer provides matches for charitable donations, please send a completed matching gift form with your contribution.

There are many funds not mentioned in this issue of *Scope*, and several have specific designated uses. If you would like information on our various funds to help you decide the best fit for your support, please call us at 919-515-3462. For a list of funds, visit www.pams.ncsu.edu/development/funds.php.

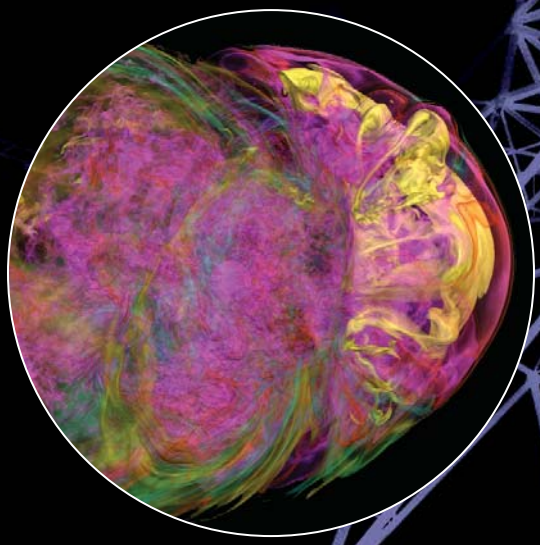
To explore other options

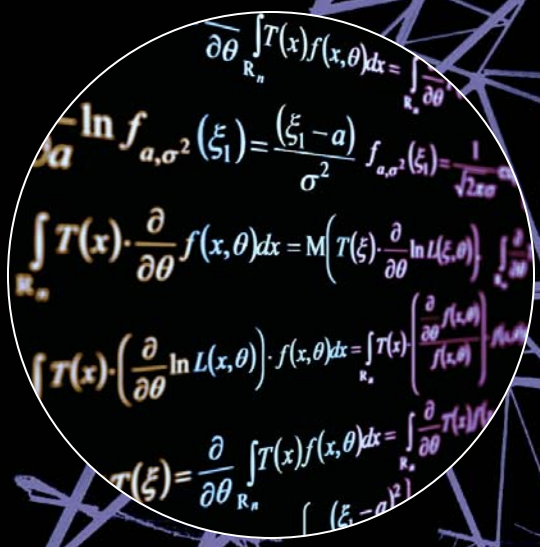
If you have questions about gift planning, we can help you identify tax benefits, choose between permanent endowment vs. one-time support, and explore estate planning or life-income options.

There are many ways to match your interests with specific College needs, and several possibilities for making your vision a reality. Whether using cash, appreciated stock, real estate or a bequest, we can help you find the best way to make the most of your gift.

Contact us at 919-515-3462 or by e-mail at pamsalumni@lists.ncsu.edu. □

2007 PAMS Alumni & Friends Weekend





October 12–13

Friday

Physics Department Celebration

Saturday

Rededication of Riddick Hall,
the Physics Department's new home

Tours of Riddick labs and facilities

Alumni & Friends College
Fox Undergraduate Science Teaching Laboratory
Featuring special classes about exciting topics:

- Tsunami!
- How much does Big Brother know about you?
- North Carolina's water challenges
- Energy options for tomorrow
- New discoveries in astronomy
- Messages from Antarctica
- Countertop Chemistry with The Science House

... and more!

Public Lecture
NC Museum of Natural Sciences

"Powering the Planet: The Challenge for Science in the 21st Century"
Daniel G. Nocera
W. M. Keck Professor of Energy
Professor of Chemistry
Massachusetts Institute of Technology

Post-Lecture Reception & Silent Auction
NC Museum of Natural Sciences

Registration information will be mailed later this summer.

Visit www.pams.ncsu.edu/weekend for more!